SOLID WASTE MANAGEMENT IN WHOLESALE FOOD DISTRIBUTION CENTERS

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PREFACE

This study of solid waste management practices in food distribution centers was funded by the U.S. Department of Agriculture, Agricultural Research Service, as Contract 12-14-100-10322(52). The engineering firm of Stearns, Conrad, and Schmidt (SCS) made a study in detail of six food distribution centers located in different areas of the United States.

The assistance of the managers, their staff, and the tenants at each of the surveyed food distribution centers is gratefully acknowledged.

The SCS project team and the Marketing Operations Research Laboratory of the Agricultural Research Service wishes to extend its grateful appreciation to the food distribution centers, wholesalers that participated in this study, and the nearly 40 other food centers which supplied information on operations and solid waste management methods at their centers. The excellent cooperation received emphasizes the high level of interest on the part of center managers in improving solid waste management methods at food distribution centers.

The cooperation and support received at each center facilitated the gathering of the required information for this report and its recommendations.

Representatives of the U.S. Department of Agriculture's Market News Service at surveyed centers provided valuable insights into center operating conditions and data on food quantities distributed.

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Solid Waste Management In Wholesale Food Distribution Centers

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INTRODUCTION

Handling and disposing of solid waste generated in wholesale food distribution centers can be a significant problem. Recent and pending antipollution legislation in some areas of the country is limiting the choice of solid waste management systems and forcing some centers to upgrade present waste management methods.

Many types of waste management systems are available. Thus, the center manager finds it difficult to select the best method, particularly in view of the limited information available to him on the subject. Among factors to be considered in selecting a method for managing solid wastes are: economic feasibility, system implementation in view of the physical characteristics of a particular center, acceptability to the tenants, and present or pending antipollution regulations. To add to the problem, many centers were built or enlarged with little thought given to managing waste materials. As a result, waste management practices at some centers are inadequate from both a sanitary and economic standpoint.

An indepth engineering study and evaluation of solid waste sources and types, waste generation rates, and methods of waste handling and disposal at selected food distribution centers were conducted. The study included onsite surveys at six centers, evaluation of waste management systems used at each center, consideration of alternative waste management methods, and recommendations for applicable alternative waste management methods. This report sets forth recommendations that resulted from the methodology and findings of the study. The report is intended for use by center management in selecting a cost-effective solid waste management system suitable for their particular center.

RECOMMENDATIONS ON SOLID WASTE MANAGEMENT IN WHOLESALE FOOD DISTRIBUTION CENTERS

1. Delegate full responsibility for solid waste management to the manager of the food distribution center. As a part of this responsibility, authorize the manager to administer all waste collection services provided tenants, to contract with private firms for solid waste collection and disposal services, or to establish center capability in terms of labor and equipment to provide for solid waste collection and disposal as required.

2. Provide each tenant of the center with, and require him to use, the proper type and number of waste storage containers, according to the type and volume of waste he generates. Use tenant containers that are uniform in size and design throughout the center. Arrange for the containers to be serviced a minimum of twice each week. Provide tenants generating larger volumes of waste with additional containers, or have their containers serviced more frequently.

3. Collect wastes from center restaurants daily. Collect office wastes from administrative offices once each week.

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4. Locate waste storage containers as near as practical to the point of waste generation. The rear dock area is convenient for tenant use and for collection service accessibility.

5. Determine the proper number of containers required for each tenant by conducting a survey at each center to supplement the general guideline information presented within this report.

6. Collect waste from elevated and street level rear dock areas with a front-end-loading packer vehicle. Use waste containers that are of the metal bin type, equipped with casters and lift handles to facilitate movement by tenants and mechanical loading.

7. When a suitable location exists at the center, carefully consider the installation of a stationary compactor. Use of a pickup truck or small three-wheeled collection vehicle is recommended for transporting tenant wastes to the compactor if the compactor cannot be located readily accessible to tenant dock locations. With this method, self-dumping containers for storing tenant wastes are recommended.

8. Because of high costs and increasingly stringent air pollution control regulations, the installation of an incinerator for disposal of center wastes is not recommended. Those centers now using incinerators should carefully compare operating costs for the incinerator with operating costs for the alternative methods of disposal discussed in this report. Terminate uneconomical incinerator operations and implement one of the alternative disposal methods.

9. Locate several large containers of 4- to 6-cubic-yard capacity on the center premises and encourage truckers to dispose of packing wastes in these containers. Alert the gate watchman to prevent any tendency for truckers to bring more than the required amount of packing wastes into the center with their produce loads.

10. Removal of center food wastes by hog farmers is not recommended as a reliable, long-term waste disposal method. If this method is considered, contact local regulatory agencies having jurisdiction over feeding of garbage to animals to determine if center food wastes can be fed to hogs without prior cooking. In addition, establish carefully prepared rules under which the hog farmer must operate to insure uninterrupted, food waste removal in a sanitary manner.

11. If local regulations permit, encourage, or require tenants processing or preparing produce for packaging, and center restaurants to install a garbage grinder for disposal of food wastes directly to the sewer system. Installation of these units during new center construction is recommended.

12. Establish center regulations requiring that dunnage originating from railroad cars be transported either to the tenants' waste storage container or to one of the large containers located for truckers' use (see item 9, above). Assess appropriate penalties to those persons observed sweeping railcar dunnage onto the ground.

13. Sweep streets and other paved areas of the center at least twice weekly with a mechanical street sweeper. To facilitate this cleaning activity, park all trucks and piggyback trailers away from the dock on designated days (during night sweeping hours). Keep perimeter fences of the center weed free and periodically clean them of litter.

14. Pave unpaved railroad track areas to facilitate the use of efficient mechanical street-cleaning methods.

15. In general, only the larger centers (those receiving at least 1,000 tons of produce daily) should consider the purchase of equipment and the hiring of labor to provide solid waste collection and disposal service for tenants. Smaller centers, particularly those privately owned, should contract with a competent private hauler for the required service. Small municipally owned centers may have access to an ongoing municipal waste collection service.

16. If the center wishes to consider establishing its own solid waste collection and disposal operation, a careful planning and evaluation period is recommended. Retain a competent consulting engineer experienced in solid waste management to evaluate center conditions and recommend the proper equipment and waste management system components for consideration. Include cost estimates for service submitted by qualified private haulers in the evaluation process.

17. Preparation of detailed specifications governing the services to be provided by the private hauler are recommended. Competent legal advice is needed for preparation of this specification.

18. The contract with the private hauler should be with the center and not with the individual tenants. All authorization for and payments to the hauler should be made by the manager or other designated center representative.

19. Selection by each center of one of the four basic solid waste management systems described on pages 37 through 44 of this report is recommended. Determine the proper system, combination of components, and equipment sizes after analyzing local conditions at each center.

DESCRIPTION AND COMPARISONS OF WHOLESALE FOOD DISTRBUTION CENTERS

General Approach

Six food distribution centers were designated by the U.S. Department of Agriculture for intensive study. At each center the project team surveyed center operations and waste management practices. The purpose of the survey was to gather quantitative and qualitative information on solid waste types; to assess the cost effectiveness of present waste handling and disposal methods; and to record descriptive information on center size, operations, and problems of waste management. Appendix A contains a copy of the data form completed by the project team at each center.

Applicable center records were examined and management interviewed to ascertain costs assignable to the waste management system used by each center. Existing problems with wastes were noted. Studies were conducted to determine or verify labor, equipment, and storage costs associated with the system in use. Discussions were also held with tenants, local contractors for waste collection and disposal services, salvage firms, representatives of local and State regulatory agencies, and Department of Agriculture representatives at the center. Local suppliers of waste-handling equipment were contacted to determine availability and costs for common types of storage, processing, and disposal equipment. Local and State regulatory agency representatives also helped define sanitation and waste management problems at the centers.

Estimates of the volume of food distributed at each center were prepared. These were based on records kept by center management, tenants, and Department of Agriculture representatives. Seasonal and daily variations in volumes of food received by the center were also recorded.

In addition to the field surveys, requests for information on solid waste practices were sent to 60 centers located throughout the United States. Information was sought on the types and volumes of food distributed, waste management practices, and problems with waste disposal at each center. Regulatory agencies having jurisdiction at the center locations were also contacted by mail and requested to supply information on local requirements imposed on center waste management systems.

Centers Surveyed

Physical Description

The six centers visited by the project team were selected to represent a wide variation in size, age, ownership, and waste management methods. Wholesalers of varying sizes were located in multiple-occupancy buildings—buildings that contain a number of individual units. The dimensions of these units varied from 22 feet to 25 feet in width and from 100 feet to 110 feet in length, including front and rear platforms. Selected descriptive information for each center is contained in table 1. To insure maximum cooperation for the survey, centers are identified by code number only.

The centers ranged in age from 2 to 19 years. Those operated under private ownership were incorporated and many tenants owned shares in the corporation. One center was municipally

TABLE 1.—*Information on food distribution centers surveyed*

Center No., type of ownership, and year opened	Total area	Number of units	Unit dimensions		Platform depth		Area per unit, including platforms	Total area leased for produce	Number of tenants	Number of units per tenant	
			Length	Width	Front	Rear				Min.	Max.
	Acres		*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Sq. ft.*	*Sq. ft.*			
1, private, 1951	36	84	60	22½	28	12	2,250	[1] 186,750	34	1	8
2, city, 1963	26	84	68	22	20	12	2,200	[2] 143,000	15	1	8
3, city, 1967	126	252	60	25	25	15	2,500	630,000	110	1	8
4, private, 1968	37	130	70	24	15	15	2,400	[3] 307,200	51	½	9
5, private, 1955	22	50	74	25	24	12	2,750	[4] 104,500	14	1	6
6, State, 1959	146	254	60	22½	25	15	2,250	[5] 510,750	51	1	16

[1] Based on 83 units.
[2] Based on 65 units.
[3] Based on 128 units.
[4] Based on 38 units.
[5] Based on 227 units.

ed and managed and another was State-ed and managed. The land area occupied ;ed from 22 to 146 acres, and the number nits ranged from 50 to 254. Tenant units ɜ approximately the same size, ranging ı 2,200 to 2,750 square feet each (including t and rear dock areas). The number of nts varied from a minimum of 14 at one er to a maximum of 110 at another center.

l Types Distributed

resh fruits and vegetables (FFV) were the lominant commodity distributed at the ers. At two centers poultry or meat process-or both were conducted and wholesale dry ery products were distributed. A small ıery was in operation at Center No. 6. Table .bulates the estimated volume of food in distributed at each center for calendar · 1969. In this report, food volumes are sured in tons rather than in the more com-carlot equivalent measure. As an approxi-ion, the reader can convert FFV tons to ot equivalents by dividing the tons by 19.

The survey indicated that centers do not keep careful records of food volumes received or distributed. The Department of Agriculture routinely maintains information on produce unloads in certain cities but not for particular centers. Records were commonly maintained by center management of gate receipts from entering trucks. It was necessary to convert these receipts and Department of Agriculture data to estimate food volumes for the purposes of this study. The daily and seasonal variations in food volumes distributed were also estimated. The maximum and minimum volume days and months for food distribution at the centers are noted on table 2. These variations are expressed in figures 1 and 2 as percentages of volumes for the average month or average day. At all but center No. 2, the high volume days occurred at the beginning of the week. In general, the period from April to August was found to comprise the high volume months, although this finding varied somewhat between centers.

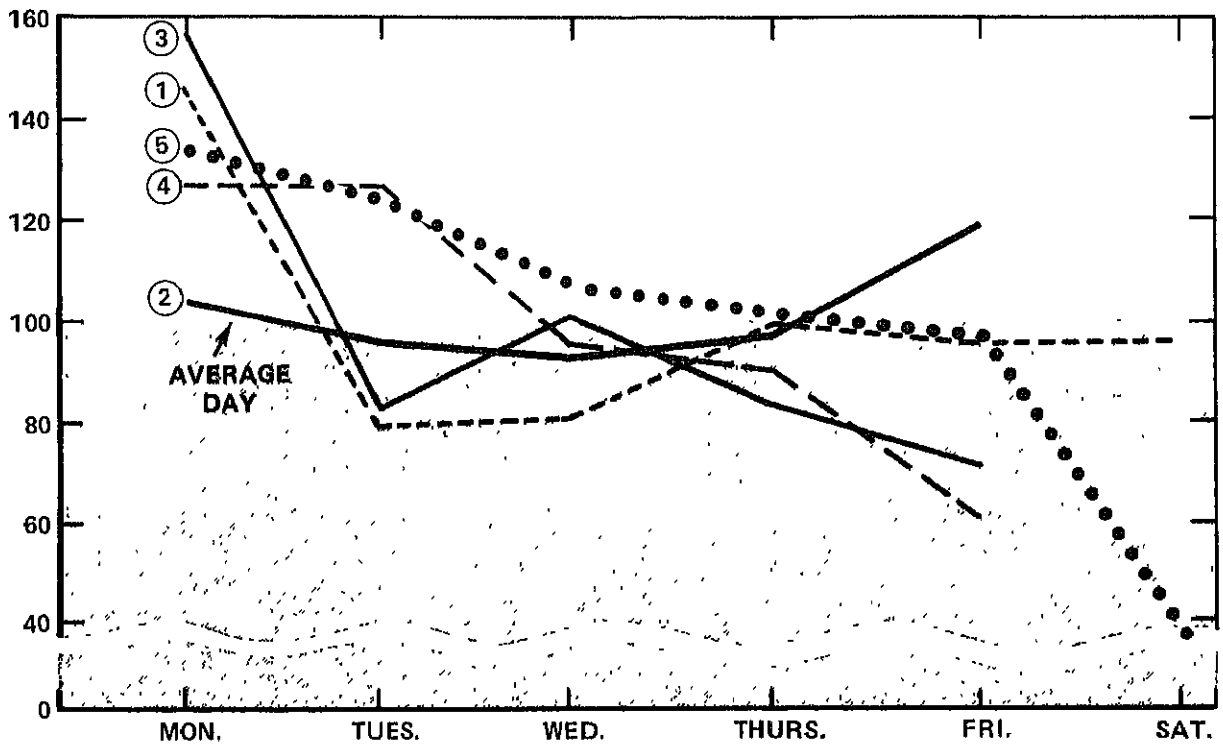


FIGURE 1.—Daily variations in volumes of fresh fruits and vegetables distributed at 6 centers.

TABLE 2.—*Volume of fresh fruits and vegetables distributed by 6 food distribution centers*

Center No.	Average volume				Variation in average volume							
					Seasonal [1]				Daily [1]			
	Yearly	Monthly	Weekly	Daily	Month	High	Month	Low	Day	High	Day	Low
	Tons/yr.	*Tons/mo.*	*Tons/wk.*	*Tons/day*		*Pct.*		*Pct.*		*Pct.*		*Pct.*
1	165,000	13,700	3,160	528	Apr.	117	Dec.	83	Mon.	146	Tues.	80
2	99,100	8,260	1,900	381	Apr.	135	Dec.	57	Fri.	119	Wed.	93
3	1,171,000	97,600	22,500	4,500	June	123	Feb.	82	Mon.	157	Fri.	72
4	303,000	25,300	5,830	1,170	Aug.	136	Feb.	79	Mon. & Tues.	126	Fri.	62
5	95,100	7,930	1,900	305	June	113	Mar.	80	Mon.	134	Sat. [2]	38
6	300,000	25,000	5,800	960	June	142	Feb.	73	[3] N.A.	166	[3] N.A.	58

[1] Percentages represent variations in average daily and monthly volumes from volumes (100 percent) for the average month and average day of one year.

[2] Market open half days only on Saturday.

[3] N.A. = not available.

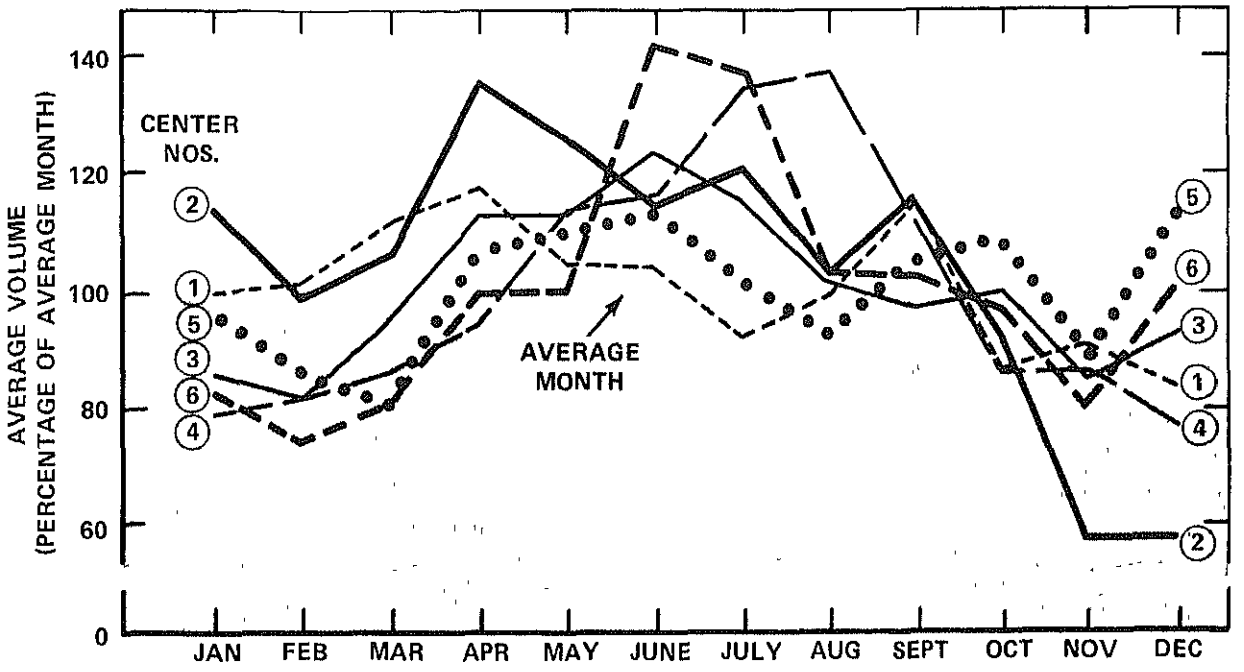


FIGURE 2.—Seasonal variations in volumes of fresh fruits and vegetables distributed at 6 centers.

Allocation of Terminal Area

Table 3 indicates allocation of area at the centers. Three centers had truck sheds or docks in addition to conventional tenant units. All centers had one or more restaurants on the premises. These ranged in size from one unit to larger cafeteria types occupying the equivalent of several units. Center administrative offices were separated from tenant buildings at three of the centers. Tenant offices were in the unit mezzanine location in all centers.

All centers were served by rail facilities. Three centers had team track areas. Track areas ranged from less than 1 acre to nearly 11 acres at the largest center. Paved areas for streets and parking totaled over 70 acres at one center. The paved areas represented an average of 60 percent of the total area. Rail and unpaved areas often posed a cleaning problem for center management.

Description and Quantity of Solid Waste Generated

At each center, measurements were made of the volume of solid waste generated by the tenants, restaurants, and administrative offices. When available, solid waste load weight data from private waste haulers or from the center were obtained. Private waste haulers at three of the centers cooperated by supplying records of billings or waste volumes, or both, collected at the centers for up to a 1-year period. Tenants were interviewed to determine how often their waste storage containers were emptied. Volume estimates were derived there from when quantitative data were lacking. Load weights of known volumes of waste were analyzed to derive average density values for solid waste.

Cleaning operations conducted in the team and house track areas and on the streets and paved areas were observed and types and volumes of waste collected were estimated by the project team.

Contents of waste containers were examined to determine the types of waste generated at each of the centers. Common wastes included culled or spoiled produce, food trimmings, paper, cardboard, wood, packing material, and dirt. For purposes of the field surveys and for subsequent consideration of alternative waste management methods, a classification system was derived to categorize wastes generated at the centers. Wastes were broadly defined as

TABLE 3.—*Allocation of space at 6 wholesale food distribution centers*

Center No.	Total area	Total space allotted to tenant building		Other space allocations							
							Offices		Railroad tracks		Streets, parking areas, and misc. buildings
		Produce	Miscellaneous	Truck docks	Restaurants	Stores	Admin.	Leased	House	Team	
	Acre	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*	*Sq. Ft.*
1	36	186,750	None	39,000	5,850	2,250	400	6,800	70,000	8,400	521,000
2	26	143,000	[1] 19,800	None	8,800	11,000	1,000	28,600	35,400	None	543,000
3	126	630,000	None	None	5,000	N.A.	2,000	157,500	226,800	235,500	2,465,000
4	37	307,200	None	None	4,800	N.A.	600	65,000	90,750	68,500	1,140,500
5	22	104,500	None	[2] 16,500	2,750	30,250	750	N.A.	51,750	None	756,000
6	146	[3] 510,750	[4] 70,000	546,000	10,400	71,400	9,125	N.A.	165,000	None	[5] 3,247,000

[1] Poultry processing.
[2] Truck docks operated under separate management, Not part of survey.
[3] Includes meat processing.
[4] Poultry and egg distribution and vegetable cannery.
[5] Includes 97,000 sq. ft. of miscellaneous buildings including maintenance, exhibit center, service station, and others.

being either food or nonfood wastes. Food wastes were further categorized as being spoiled food or food scraps. Spoiled food included whole fruits and vegetables or other foods. Food scraps included trimmings resulting from processing operations and restaurant garbage. Nonfood wastes were categorized as corrugated cartons, wood scraps, and paper. Other items found in waste storage containers were noted separately.

Nearly all solid wastes found at the centers could be readily included in one of the above categories. One center, for example, had a poultry processor that generated a small number of tin cans and some strap metal binding wastes.

Also important in the consideration of alternative waste management methods were the moisture content, putrescibility, combustibility, and compressibility of the center wastes.

The moisture content is, as the name implies, the proportion of the waste that is liquid. It is usually expressed as a percent of the weight of the waste and is particularly important when incineration is considered as a waste disposal method. The moisture content of center wastes can be affected by climatic conditions. For example, paper or corrugated cartons stored outside in a waste container can absorb a considerable quantity of rainwater.

The putrescibility of a waste is a qualitative measure of its tendency to decay, rot, or decompose. Highly putrescible wastes must be properly containerized and frequently removed for disposal to prevent problems of odors and fly propagation.

The combustibility of wastes is generally related to the moisture content. Those wastes having a low moisture content are more combustible (readily burned) than those with a high moisture content. Combustibility is also a qualitative measure.

Compressibility is a measure of the degree of volume reduction that a waste undergoes when placed under pressure. It depends primarily on structural characteristics of the waste and the amount of pressure applied. Compressibility is important when waste management methods involving central storage, collection, and hauling are considered.

Table 4 presents the characteristics of the solid wastes found at the six centers during the surveys.

Of importance in waste management considerations is the relationship between the weight of solid waste generated and the volume it occupies. This relationship is commonly referred to as the density and is measured in terms of pounds per cubic yard of waste.

The density will vary with the waste type. Loosely piled cardboard boxes have a low density, whereas discarded produce such as cantaloup will have a much higher density. Density measurements made by the project team on various wastes loosely placed in waste storage containers ranged from less than 100 pounds per cubic yard to more than 900 pounds per cubic yard.

TABLE 4.—*Characteristics of solid wastes at 6 wholesale food distribution centers*

Waste type and category	Moisture content (percentage of wet weight)	Putrescibility	Combustibility	Compressibility
Food:				
Spoiled	80–95	High	Low	Medium
Scraps	80–95	Medium	do.	Do.
Nonfood:				
Corrugated cartons	20–25	Low	Medium	High
Wood	25–35	do.	do.	Low
Paper	20–25	do.	High	Medium

Table 5 provides representative average density figures and ranges for common solid wastes found at the centers.

Table 6 presents the estimated volume of solid waste by major source and type at each of the centers. Tenant wastes include those generated within the tenant units and cleaned from rail track areas of the center. Tenant office wastes (such as paper) are also included under the "Tenants" heading in table 6. Wastes from the center administration offices and any leased space therein are included under the "Offices" heading.

The "Total waste" column includes all solid wastes generated by the centers. Note that volumes of food and nonfood wastes on a weight basis were found to be approximately equal at most centers. The last column of table 6 presents the volume of solid waste generated per ton of food distributed. Solid wastes generated per ton of food distributed ranged from a low of 0.007 tons (14 pounds) at center No. 3 to a high of 0.018 tons (36 pounds) at center No. 1. The average volume for the six centers surveyed was 0.01 tons, or 20 pounds of solid waste per ton of food distributed.

Figure 3 graphically depicts the relationship between the quantity of food distributed and the total quantity of solid waste produced, as determined from the surveys.

The estimated annual volume of tenant solid waste generated per square foot of tenant unit was calculated and is tabulated in table 7. The amount would be expected to vary significantly with the quantity and type of food distributed by a particular tenant. Food processing or packing would also affect the quantity. The average quantity for the six centers was 15 pounds per square feet per year.

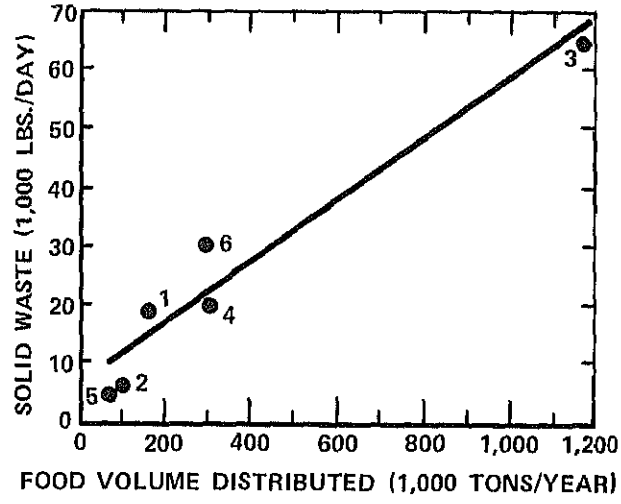


FIGURE 3.—Relationship between volume of food distributed and total volume of waste generated at 6 food distribution centers.

Information From Other Centers

Information on center operations and waste management methods was requested from managers of 60 centers throughout the country. A total of 38 centers located in 18 different States cooperated by supplying information. The cooperating centers served urban areas populated by over 45 million people.

Table 8 tabulates responding centers by location.

TABLE 5.—*Density of solid wastes at 6 wholesale food distribution centers*

Waste type and category	Average density in loosely piled waste	Variations in average density	
		High	Low
	Lb./cu. yd.	*Lb./cu. yd.*	*Lb./cu. yd.*
Food:			
Spoiled	685	950	400
Scraps	685	950	400
Nonfood:			
Corrugated cartons	75	200	50
Wood	200	350	150
Paper	150	200	100

TABLE 6.—*Volumes of solid waste generated at 6 wholesale food distribution centers*

Center No.	Volume by major source									Total volume of all waste			
	Tenants [1]		Trucks docks		Streets and parking lots		Restaurants		Offices (admin. and leased), nonfood	Tons per day		Tons per year	Ton per ton of produce
	Food	Nonfood	Food	Nonfood	Food [2]	Nonfood [2]	Food	Nonfood		Food	Nonfood		
	Tons/day												
1	3.9	3.0	1.6	1.0	[3]	[3]	0.05	0.04	0.02	5.55	4.06	3,000	0.018
2	1.7	1.2	[2] None	[2] None	[4] N.A.	[4] N.A.	.14	.16	.04	1.84	1.40	[5] 840	.008
3	15.5	10.6	do	do	1.8	5.2	[3]	[3]	[3]	17.30	15.80	8,600	.007
4	4.1	2.1	do	do	.40	3.6	[3]	[3]	[3]	4.50	5.70	2,650	.009
5	2.6	.5	[6]	[6]	[4] N.A.	[4] N.A.	.05	.05	[3]	2.65	.55	1,000	.011
6	[7] 5.2	[8] 2.6	4.0	2.0	[3]	[3]	.12	.07	[9] 1.20	9.32	5.87	4,700	.016

[1] Includes house and team track wastes.
[2] No truck docks at center.
[3] Included in the first and second columns.
[4] N.A. = not available.
[5] Excludes wholesale grocery and poultry processor.
[6] Not part of survey.
[7] Includes 0.6 tons/day from poultry processing, wholesale grocery, cannery, and meat handling establishments.
[8] Includes 0.4 tons/day from poultry processing, wholesale grocery, cannery, and meat handling establishments.
[9] Includes service station, maintenance building, and areas rented for crate and box distributors.

TABLE 7.—*Annual quantity of solid waste generated by the tenants at 6 wholesale food distribution centers*

Center No.	Tenant units		
	Area occupied	Waste quantity	
		Daily [1]	Annual
	Sq. ft.	*Ton/day*	*Lb./sq. ft./yr.*
1	186,750	6.9	23
2	143,000	2.9	11
3	630,000	26.1	22
4	307,200	6.2	10
5	104,500	3.1	18
6	510,750	[2] 6.8	8

[1] Includes house and team track wastes.
[2] Excludes 1 ton/day from poultry processing, wholesale grocery, and cannery in separate buildings.

Opening dates for the responding centers varied from 1918 to 1967, with the median date being 1954. Table 9 lists the opening dates in 10-year increments for 35 of the 38 responding centers.

Figure 4 illustrates a typical configuration for tenant units. The front and rear platforms are used for loading and unloading produce, and the units serve as food storage, preparation, and distribution areas. A few of the smaller centers reported using large farm sheds (up to 448 feet long by 110 feet wide) rather than the more typical unit construction. House tracks are typically located at the rear of the multiple-occupancy buildings.

Table 10 relates center size and unit dimensions to population in the tributary area. Locations having a tributary population greater

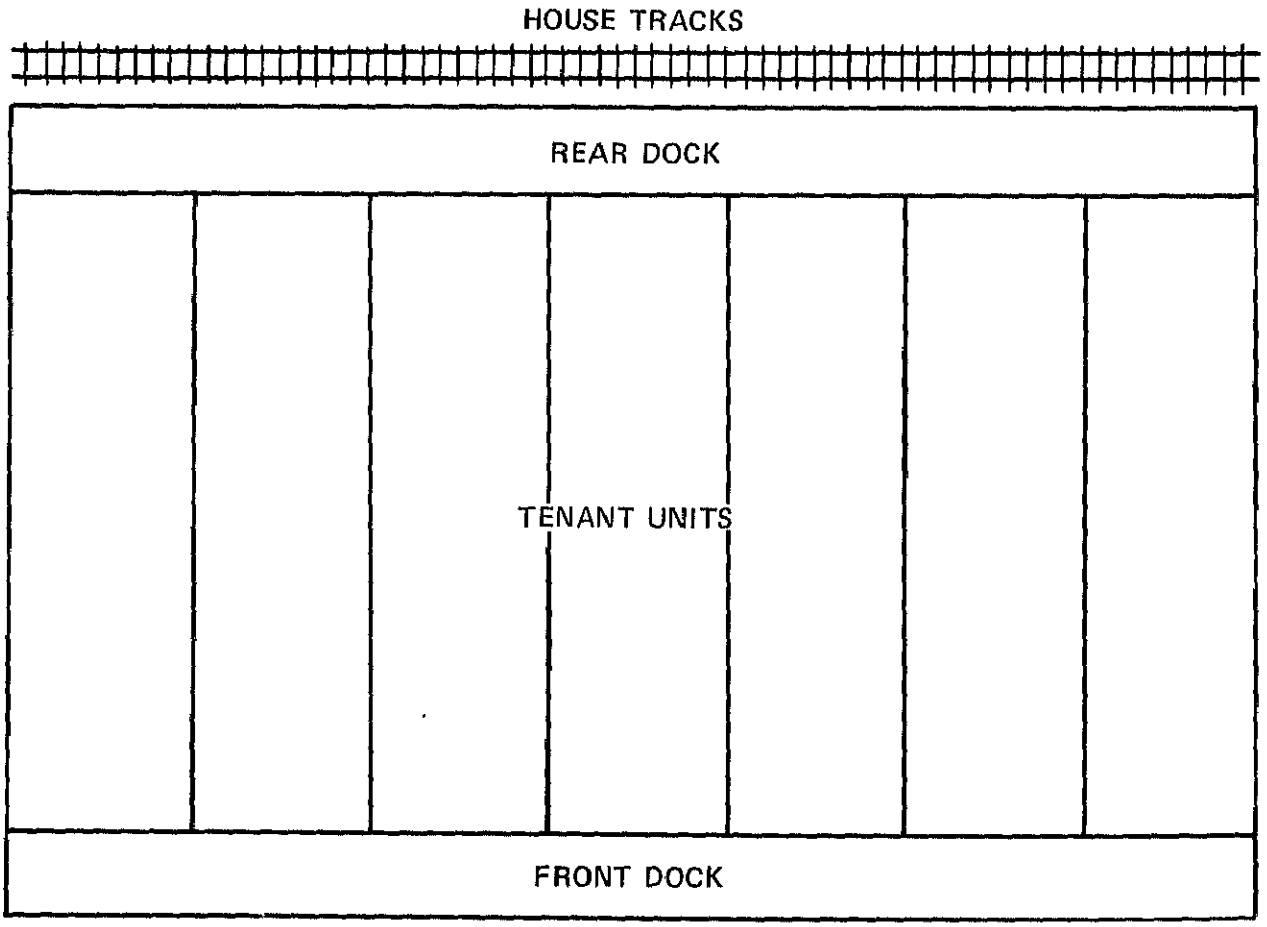


FIGURE 4.—Typical configuration of tenant units in a multiple-occupancy building.

TABLE 8.—*Number of centers supplying data, by State*

State	Number of centers	State	Number of centers
Alabama	1	Missouri	1
California	2	New Jersey	4
Connecticut	1	New York	5
Florida	6	North Carolina	1
Georgia	4	Ohio	2
Kentucky	1	Pennsylvania	1
Maryland	1	South Carolina	2
Massachusetts	1	Texas	3
Michigan	1	Utah	1

than 100,000 used the typical unit layout almost exclusively. At these locations the average unit width varied between 18 and 23 feet and the average unit length varied from 46 to 73 feet. The number of units per center ranged from a maximum of 249 for the largest responding center to a minimum of 13 for the smallest center.

Nearly 60 percent of the responding centers indicated private ownership. There was a trend toward private ownership in the centers located in larger urban areas. More than 70 percent reported private ownership in the 500,000-and-over population category.

Ninety percent of the privately owned centers reported waste disposal service by private contractors. Nearly half of the city- or State-owned centers used private contractors for waste disposal service. Sanitary landfill and the hog farmer were cited most frequently as the method for waste disposal. Six centers reported the use of incinerators for waste disposal. Table 11 presents center ownership and waste management service responsibility, by population.

All responding centers reported that the major commodities distributed were fresh fruits and vegetables. Other items reported included grocery products, poultry, eggs, meats, fish, nuts, and horticultural products.

Table 12 relates center size, measured by food volume distributed, to tributary population.

The markets were requested to supply information on current costs for waste collection and disposal. The few managers who responded to this request apparently misunderstood the question or did not have ready access to the requested figures. Approximately 10 percent

TABLE 9.—*Range of opening dates for responding centers*

Years	Number of centers
1910–1920	2
1921–1930	1
1931–1940	6
1941–1950	5
1951–1960	15
1961–1970	6

TABLE 10.—*Average size of tenant units in responding centers, by population*

No. of centers and population range (1,000's)[1]	Average No. of units	Average space per unit				Average land area
		Building area		Platform area		
		Length	Width	Front	Rear	
		Feet	*Feet*	*Feet*	*Feet*	*Acres*
10, 10–100	[2]N.A.	[2]N.A.	20	14	9	19
4, 100–500	50	46	18	17	8	20
12, 500–1,000	54	66	22	19	12	32
12, 1,000 and over	124	73	23	20	12	39

[1] Population data is from the U.S. Bureau of Census' Statistical Abstract of the United States: 1970. Ed. 91, Washington, D.C. 1970.

[2] N.A. = not applicable.

TABLE 11.—*Type of ownership and waste collection and disposal service in responding centers, by population*

Range in population (1,000's)	Centers under—		Centers collection and disposing of waste by—		
	Public ownership	Private ownership	Public service	Private service	Both
	Number	*Number*	*Number*	*Number*	*Number*
10–100	7	3	3	3	4
100–500	3	1	3	1	
500–1,000	3	9	1	8	3
1,000 and over	4	8	1	7	4
Total	17	21	8	19	11

TABLE 12.—*Annual volume of food distributed by responding centers, by population*

Range in population (1,000's)	Fresh fruits and vegetables	Other foods	Total
	Tons/yr.	*Tons/yr.*	*Tons/yr.*
10–100	43,000	N.A.	43,000
100–500	150,000	2,000	152,000
500–1,000	126,000	3,000	129,000
1,000 and over	326,000	4,000	330,000

indicated that waste disposal was free or that the cost was unknown.

Managers were requested to comment on special problems experienced with solid waste collection and disposal at their centers. Managers of two smaller centers stated there were no significant problems. Several managers commented on the laxity of tenants in cleaning up their own waste and placing it in proper containers. Other comments are indicated below in the order of frequency (highest to lowest):

- Landfill sites too far distant for economical disposal.
- Garbage grinder not available or not permitted.
- Refuse contractor often misses collection date.
- Mobile (portable) containers often blow off loading dock.
- Frequent turnover of refuse contractor.
- Liquids in refuse create problems.
- Customers often litter grounds.

WASTE MANAGEMENT AT FOOD DISTRIBUTION CENTERS

Several variations of solid waste management systems were found at the six centers surveyed. These variations resulted from differences in center ownership, the importance of sanitation to center management, and local regulations governing waste disposal. The age and physical condition of the grounds and buildings were factors in efforts to maintain some centers in a sanitary condition. Crowded conditions often made waste collection opera-

tions difficult. The degree of cooperation afforded to center managers by the tenants in maintaining center sanitation also varied.

Methods Used by Centers

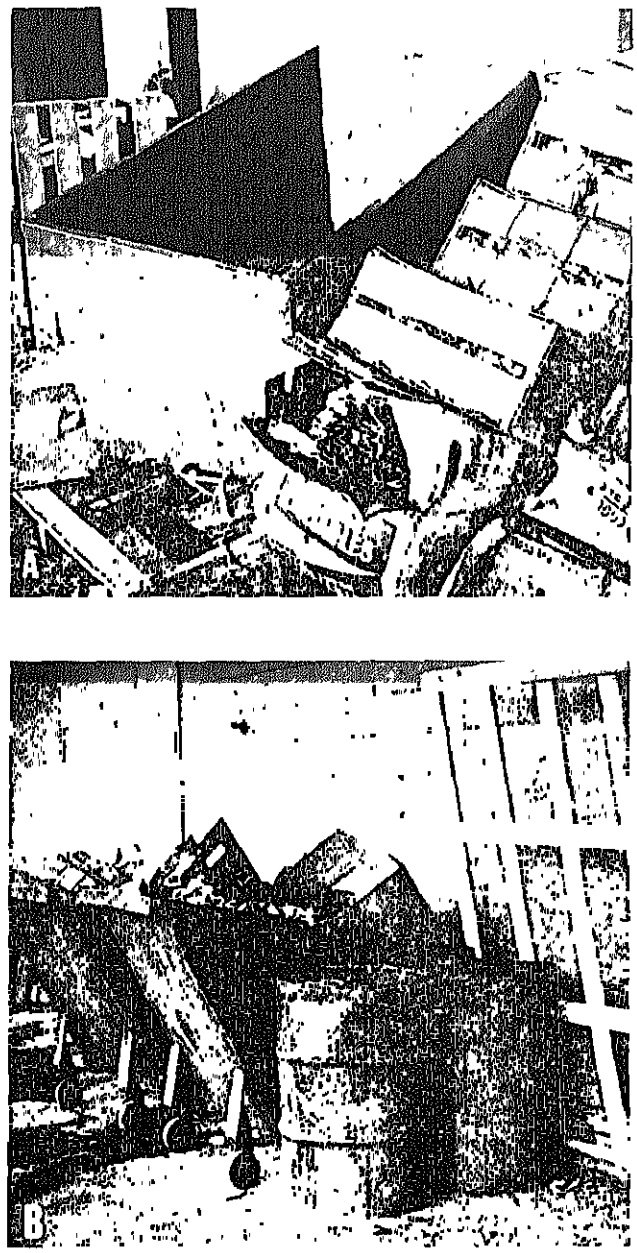
The project team found sanitary conditions better than the average for the group at Center Nos. 2, 4, and 6. The conditions at these centers generally reflected tenant acceptance of the need for proper containerization and frequent waste collection service. Management also expressed concern for sanitation and enforced center rules governing waste management.

At all centers surveyed, it was the responsibility of the tenants to keep his leased unit(s) clean and sanitary. At all but one center, this was accomplished by hand sweeping waste from the stall floor and placing it in waste storage containers at the close of each day's operations. Water flushing also was commonly used. Containers for wastes were provided by the tenants at one center and by the collection contractor at four other centers. Only one center provided containers for tenant use. At Center No. 1, tenants were permitted to sweep stall wastes onto the ground for cleanup by a center crew.

Many types of waste storage containers were in use at the centers. Tenants frequently used salvaged 55-gallon oil drums and 1 to 3 cubic-yard metal bin containers for waste storage. In the tenants' buildings, waste containers were usually placed on the rear dock. Collections were then made from this location. However, at Center No. 3 the house tracks were unpaved, and it was therefore necessary to move the containers to the front dock for collection service. At Center No. 6, several large containers were located in open areas for use by truckers after unloading. This practice helped alleviate unauthorized dumping of packing wastes in isolated areas of the center and on roadsides outside the center, a common problem at other centers. Figure 5 shows the unsanitary conditions resulting from the lack of adequate containers. All locations shown are on the rear dock areas.

As examples of commonly used waste management methods, the procedures used at the surveyed centers are described in the following pages of this section. Descriptions for some centers are brief to avoid repetition.

At Center No. 1, tenants were permitted to sweep all nonfood wastes off front and rear docks to the ground. Some food wastes were almost always included. Handbrooms were used by a three-man center crew for cleaning the ground near the dock areas, and wastes were



PN-3357/PN-3358

FIGURE 5.—Typical methods of storing wastes on rear docks: *A*, Containers not used; *B*, self-dumping hoppers and 55-gallon drums.

carried in cardboard boxes to one of two center dump trucks. One member of the crew drove the truck and flattened cardboard boxes and other bulky waste materials to decrease the waste volume. An average of 4 tons of wastes were collected daily by this method. When the truck was loaded, it was driven approximately 12 miles one way to a landfill operated by the municipality. Free disposal was provided by the municipality. Remaining members of the crew continued cleanup operations with the second dump truck. Cost for collection and disposal of these nonfood wastes based on records supplied by the center, averaged about $17 per ton of waste. Labor costs accounted for approximately 80 percent of the cost.

The waste materials collected by the cleanup crew consisted primarily of cardboard boxes, small amounts of food waste, wood pallets, and paper materials. This primitive method of center cleanup is illustrated in figure 6.

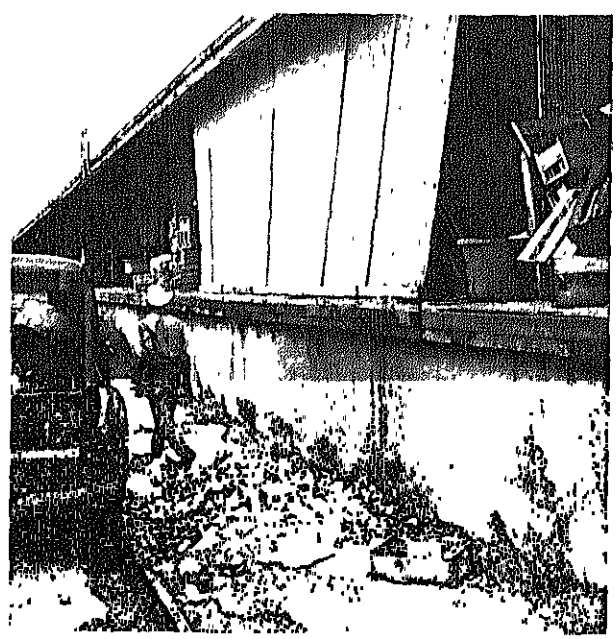
Food wastes at Center No. 1 were collected at no cost to the tenants by a number of hog farmers. The farmers were active throughout the day removing food wastes from the rear dock areas of the tenants. Center management collected a $1 annual fee from each farmer as a permit to enter the center. More than 20 permits were in effect at the time of the survey. Food wastes were placed in wooden crates or cardboard boxes by the tenants for collection by the farmers in small pickup trucks or private automobiles. A hog farmer collecting food wastes is shown in figure 7. Farmers often were observed separating the more desired food materials from the total waste and then dumping the remainder onto the ground, thus contributing to unsanitary conditions at the center. Center management estimated that approximately 5 tons of food waste were removed daily by this method. Approximately 165,000 tons of fresh fruits and vegetables were distributed in 1969 by Center No. 1.

Local health department officials expressed concern for sanitation practices at this center. There had been many complaints of rats in nearby residential areas, and the available food source at the center was believed partly responsible.

In contrast to the operation described for Center No. 1, Center No. 6, a State-owned center, used modern equipment for waste collection. This center received approximately 300,000 tons of fresh fruits and vegetables in 1969. Two front-end-loading packer collection

PN-3359

FIGURE 6.—Member of center cleanup crew picking up refuse by dock.



PN-3360

FIGURE 7.—Hog farmer collecting food wastes.

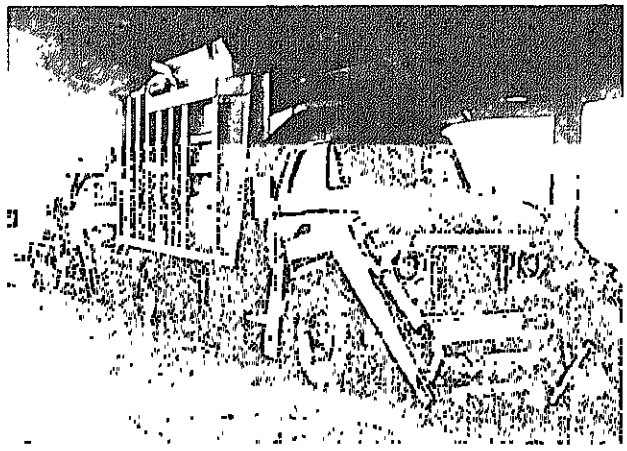
vehicles and a number of 3-cubic-yard and 6-cubic-yard bin-type containers were purchased by the center. Each tenant was supplied with sufficient container capacity for his individual waste storage needs. Two mechanical street sweepers also were purchased and operated by the center crew. Each mechanical sweeper required one man for operation. The cleanup crew totaled 11 men who worked 6 days each week. A driver and one or two loaders were assigned to each packer truck. Handbrooms were used by the crews to clean areas inaccessible to the sweepers.

The collection vehicles were equipped to hydraulically lift and empty each waste storage container. All solid wastes from Center No. 6 were taken to a privately operated landfill located about 3 miles from the center. A disposal charge of $4 per load was paid by the center. Tenant containers were stored on the rear dock and several containers were placed in the open areas of the center. Center 6 was clean and sanitary and had few problems. The survey team noted, however, that labor productivity could be improved at this center.

Costs for collection and disposal of all wastes averaged about $19 per ton and reflected the additional capital investment for equipment. Labor costs at center 6 represented about 65 percent of the total cost for waste management. The collection vehicles are illustrated in figure 8.

At the remaining centers, private refuse collection contractors provided containers and collected wastes on a schedule to suit the needs of the tenant. Tenants requested service and were periodically billed by the contractor. The billings were based on the volume of waste collected or the number of times containers were emptied.

Center No. 3 was a very large, relatively new, municipally owned market that had an extensive but inefficient system for waste management. A combination of methods were used at this center. Tenants individually contracted with a private refuse hauler for collection of containerized waste. The hauler bid for and was granted an exclusive franchise for collection of center wastes by the municipality. As part of his bid, the contractor paid an annual lump sum toward the overall operating



PN-3361

FIGURE 8.—Modern collection vehicles.

costs of the market. The current contractor paid $17,500 to the municipality annually. The contractor used two men and a 20-cubic yard rear-loading compactor truck. The contractor for collections had containers available for tenant use, but few tenants chose to use them. Instead, wastes were usually stored in corrugated cartons or wooden crates. Salvaged 55-gallon oil drums also were used. Each time wastes were collected, the collection truck driver estimated the volume of wastes and wrote a billing ticket for the tenant. A duplicate of the ticket was kept as the basis for monthly invoice for service.

The municipal sanitation department furnished an eight-man crew for nightly cleaning of streets and parking areas. Two packer trucks, two mechanical street sweepers, and a front-end loader were used by the department. The center furnished a six-man crew for cleanup in the team track area and for routine maintenance work. All wastes were disposed of in a municipal landfill. Solid waste management at this center cost in excess of $350,000 annually, or about $41 per ton of solid waste removed.

At Center No. 2, local regulations of the municipality required that all tenants contract with a private refuse contractor for collection service. Rates for service were set by the municipality, and various levels of service were available depending on the needs of the tenant. Containers of various sizes were provided by the contractor, and collection frequency was

available from once weekly to daily. Streets in this center were a part of the municipality's street system and were cleaned daily by a city crew using mechanical street sweepers. Problems with sanitation at this center were limited to complaints by some tenants of unauthorized use of their container by other tenants.

Cooperation from the tenants for individual unit cleanup at all centers was good; however, concern for general center sanitation by tenants varied. At three centers, the tenant also had responsibility for cleaning the house track area adjacent to his unit or units. Managers found this requirement difficult to enforce and unsanitary conditions often resulted. An example is illustrated in figure 9. The same condition was found at other centers where management retained responsibility for cleanup of all areas outside the units.

At Center No. 4, a private contractor provided all waste collection and disposal services under a year-to-year contract. Bin-type waste storage containers equipped with casters were provided to each tenant. The bins were identified with the tenant's unit number which was painted in large numbers on each bins side. Each day, following center closing, the contractor's collection truck visited the center and emptied containers that had been placed on the front docks. The truck driver noted the number painted on the side of the container as a basis for the monthly billing sent to the tenant.

PN-3362

FIGURE 9.—Wastes discarded in house track areas.

The contractor also cleaned the streets, parking areas, and house and team track areas once each week. Usually, two packer trucks, a skip loader, a mechanical street sweeper, and an open dump truck were used. Large amounts of railcar dunnage and other wastes accumulated during the week and caused the sanitation and appearance of the center to suffer. More frequent cleaning was needed. All collected wastes were taken to a privately operated landfill.

At Center No. 5, the tenants contracted individually with two private refuse haulers for waste disposal. A few of the tenants also had arrangements with hog farmers for disposal of food wastes. Storage containers were provided by the haulers. These containers were 1½- and 2-cubic-yard bins and were used with front-end loading trucks. A few 30- and 55-gallon drums were also used, primarily for storage of food wastes.

Most tenants had their wastes collected two or three times each week. The hauler would make special collections of larger quantities of spoiled produce on call. All wastes, except that removed by hog farmers, was disposed to a landfill.

Cleanup of street and parking areas was provided by the market. This was accomplished by one man and an open dump truck. Several times each year the perimeter fences were cleaned of refuse with the use of a skip loader.

Garbage grinders were in use at four of the center locations. Their use was prohibited by local regulatory agencies at other locations. Tenants using grinders processed food for packaging and used the grinder to dispose of trimmings and culled food. Often the grinder was installed as a part of the processing operation, with the trimmings falling directly into the grinder.

Grinders of 5 to 7 hp. each with a rotating cutter plate for grinding were used. At one center, a tenant used a hammer mill type of grinder satisfactorily. Tenants indicated they

had no problem with sewer stoppage provided sufficient water flow was maintained during grinder operation. Some had installed automatic switches on their grinders to insure that water flowed during operation and continued for several minutes after the grinder was stopped.

Cleaning of Streets and Parking Areas

Cleaning of streets and other paved and unpaved areas of the center was the responsibility of either the center or the municipality. The center either contracted for cleaning or used center personnel and equipment for cleaning. The municipality routinely cleaned the streets if they were a part of the municipal street system or if the center was municipally owned. Equipment for cleaning included skip loaders, mechanical street sweepers, dump trucks, and compactor collection vehicles. Some hand labor using pushbrooms also was used. Street cleanup operations at one center are illustrated in figure 10.

Some managers attempted to hold tenants responsible for cleaning house track areas and areas in front of their respective stalls. Only limited success was reported.

Wastes found on streets included food, wood, discarded pallets, paper, and cardboard. The amount depending in large part upon the frequency of cleaning, degree of responsibility demonstrated by tenants, and the attitude of center management.

Mechanical sweepers were effective for street cleaning only after larger items of waste had been removed by hand or with a skip loader. Because of traffic congestion, street and parking areas were cleaned in the late afternoon or early evening when center activity was at a minimum. Trucks and piggyback trailers left parked overnight at the docks were a constant problem because they interfered with these cleaning operations. Management at Center No. 3 instituted a requirement that all such vehicles be parked away from dock areas overnight to facilitate street cleaning activity. Citations and fines were issued for enforcement. The program was effective and improvements in center cleanliness were obtained.

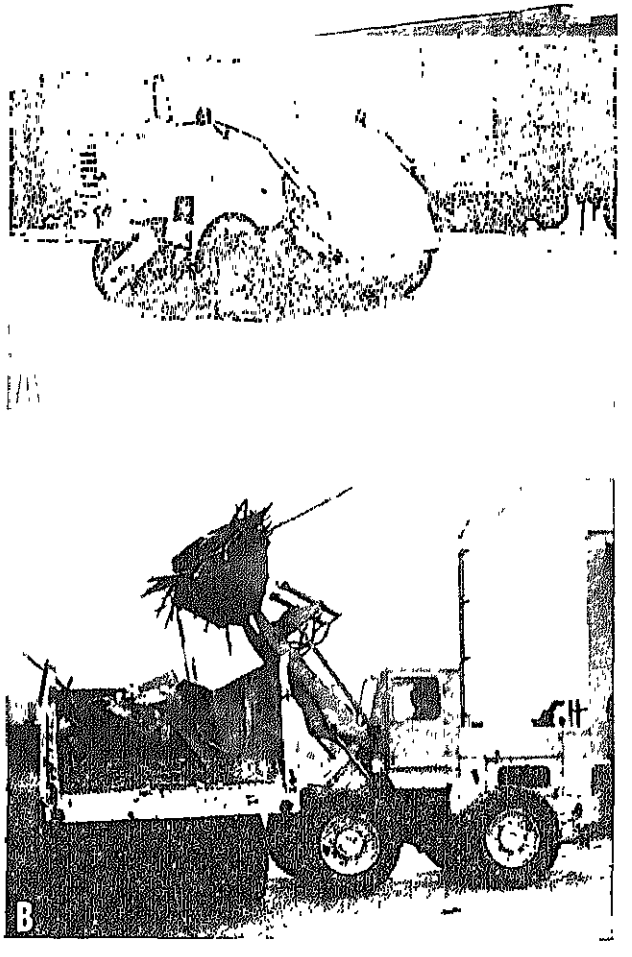


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FIGURE 10.—Street-cleaning operations at wholesale food distribution center: *A*, Mechanical street cleaner; *B*, skiploader loading bulky wastes into truck.

Rail Track Cleaning

The house and team track areas posed a difficult cleaning problem. Dunnage from railroad cars accumulated in these locations and it was difficult to schedule waste removal before more railcars were spotted for unloading. Managers reported that railroad companies were requiring that railcars be more thoroughly cleaned before their return. Often railcars were moved at night, leaving little or no opportunity for area cleaning. At all centers, railcar dunnage was shoveled from the cars onto the track areas for later cleanup, as shown in figure 11.

PN-3365

FIGURE 11.—Railroad car dunnage.

The waste from railroad cars was composed primarily of wood and other lightweight packing materials. Mechanical sweepers cannot readily pick up this type of waste. A skip loader, however, can be effectively used provided the track areas are paved and railcars moved. Otherwise, hand labor is required. A serious railcar-dunnage cleanup problem aggravated by the lack of paving is illustrated in figure 12.

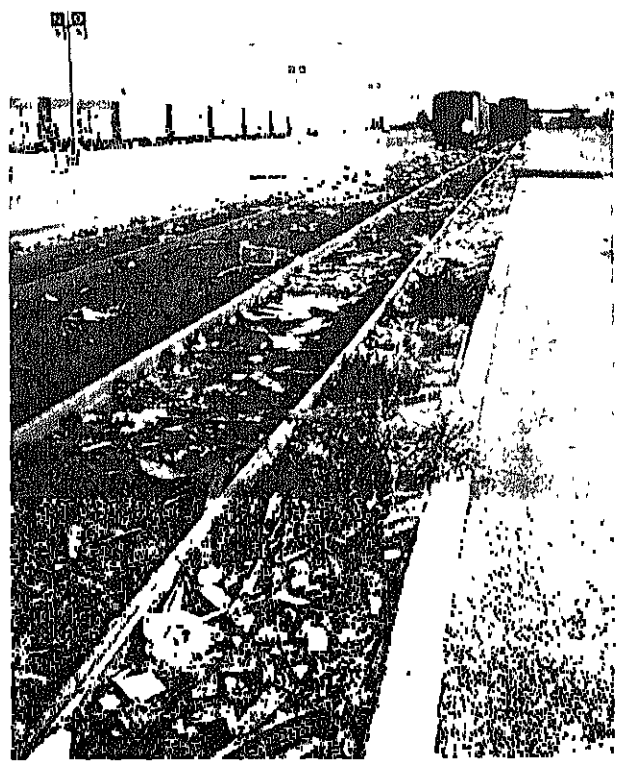
The amount of dunnage varied with the number of railcars received at the centers. At Center No. 2, management reported that fewer than 100 railcar deliveries were made annually. Consequently, the problem of railcar dunnage at this center was small. In other centers, however, as much as 50 percent of the produce arrived by rail. Cleaning of track areas was a costly problem at these locations. It was estimated that Center No. 3 received about 35,000 railcards annually. Wastes from railcars was estimated to total 6 tons daily at this center.

Final Disposal of Wastes

All solid wastes collected from the surveyed centers, with the exceptions of food wastes collected by hog farmers and wastes burned in one small incinerator operated by a poultry processor, was disposed of in sanitary landfills. The landfills were operated either by a private firm or by a municipality. At one location, wastes were taken to a nearby transfer station for transport by barge to a distant landfill. None of the centers operated their own disposal site, nor did any manager indicate future plans to do so.

Incineration was almost nonexistent. Existing incinerators at several centers had been abandoned because of local air pollution regulations and high operating costs. Survey findings include two instances only of incineration. In one instance, a poultry-processing firm located at Center No. 2 had installed a small gas-fired incinerator shortly before the survey for disposal of cardboard cartons. (Because contaminated meat cartons are not reusable, the poultry processor was faced with a large volume of cardboard waste to dispose of each day.) Another instance of incineration was found at Center No. 6, where a 1-ton-per-hour double-chamber incinerator was operated infrequently for the disposal of wood pallets.

At all the centers, instances occurred where substantial quantities of produce became unsalable. Charitable organizations often were notified when this occurred and were given the



PN-3366

FIGURE 12.—Littered unpaved team tracks.

produce at little or no cost. At one center, a tenant routinely accepted marginal produce and marketed it at a discount. On occasion, unsalable produce was taken to landfills for regular disposal with other wastes.

Cost of Solid Waste Management

Total annual costs for waste collection and disposal at the surveyed centers, exclusive of unit cleanup costs incurred by tenants, ranged from a low of $7 per ton at Center No. 1 to a high of $41 per ton at Center No. 3, and averaged $25 per ton for all centers. The low cost at Center No. 1 reflects the free collection of food wastes by hog farmers. Table 13 tabulates unit costs for each of the surveyed centers.

Time studies at several centers and discussions with tenants indicated that daily unit cleanup requires about 1 man-hour per unit. Based on average labor rates for tenant employees, daily unit cleanup costs averaged about $0.13 per 100 square feet of unit space. On an annual basis, the cost for cleanup to a tenant with two units containing 4,500 square feet of space, including front and rear platforms, would approximate $1,500. An indirect cost for solid waste management not included in table 13 is the cost of unit space occupied by waste storage containers. Floorspace value can be approximated from unit rental rates. The annual rental cost per square foot in the surveyed centers ranged from $0.80 in an older center to a high of $2.45 per square foot in a new center. Table 14 presents the estimated labor cost for unit cleanup and the value of unit space at each center.

Problems in Waste Handling and Disposal

Problems with solid waste cited by managers and noted by the project team were similar for all surveyed centers. Access to waste storage containers on dock areas by collection vehicles during operating hours was a serious problem. This problem made waste collection time consuming and expensive, and sometimes delayed produce deliveries. Even after normal working hours, trucks and piggy-back trailers often were parked overnight at the docks. When rear docks were used as the access point for collection of wastes, railcars often blocked this access.

At some locations, tenants were charged for disposal of wastes placed into containers; however, wastes on the ground were picked up by municipal or center personnel. Although rental rates reflected the actual cost for ground cleanup service, many tenants were of the opinion that this service was free. Thus the tenant had an incentive for discarding wastes onto the ground, rather than using the waste containers. Efforts by center management to police this practice often led to friction with tenants.

Another problem noticed by the project team was caused by truckers who dumped packing wastes in isolated areas of the center, or on side streets and vacant lots adjacent to the center property. Although the latter practice was of less concern to management than the former, it contributed to depressed property values in the center area and neighborhood discontent. The wastes also provided harborage for rats and other vermin. Management expressed the opinion that many truckers were purposely bringing solid wastes to the center for disposal.

There was a general lack of adequate waste storage containers. Even those tenants who received routine collection service often did not have the required number of containers to contain all wastes between days of service. Litter and spilled refuse were common and often caused delays for the crew completing the waste collection work. Discarded wooden pallets were a special problem because of their size and because they could damage refuse collection vehicles unless properly handled.

Tenants complained of unauthorized use of their containers. Containers were often overfilled by tenants attempting to reduce their costs for disposal. More frequent service or provision of a larger container to prevent overflow were resisted by the tenant because these services would increase his billing from the collection contractor.

Many existing containers were in need of repair. Lids were almost nonexistent and casters on many containers were broken or unusable. Many tenants used forklift trucks to move containers loaded with wastes because of damaged container casters.

Inspection of emptied containers indicated

TABLE 13.—*Annual costs for collecting and disposing of solid wastes at 6 wholesale food distribution centers*

Center No.	Cost for collecting and disposing of wastes from—				Annual volume of waste	Annual cost for waste removal and disposal
	All areas except offices [1]		Administrative and tenant-leased offices	Total		
	By center management	By contractor or municipality, or both				
	Dol./yr.	*Dol./yr.*	*Dol./yr.*	*Dol./yr.*	*Tons/yr.*	*Dol./ton/yr.*
1	21,200	--	[2]	[3] 21,200	3,000	7.07
2	--	[3] 10,700	400	[4] 11,100	[4] 840	[4] 13.21
3	120,000	192,300	43,000	355,300	8,600	41.31
4	--	38,300	2,700	41,000	2,650	15.47
5	1,600	8,400	[2]	10,000	1,000	10.00
6	88,200	--	[2]	88,200	4,700	18.77

[1] Does not include costs incurred by tenants for cleaning their respective units.
[2] Included in columns 2 and 3.
[3] Food wastes collected without charge by hog farmers.
[4] Excludes wholesale grocery and poultry processor.

TABLE 14.—*Unit cleanup costs and floorspace values at 6 wholesale food distribution centers*

Center No.	Labor cost for unit cleanup	Total area leased for produce	Operating days per year	Estimated cost of cleanup to tenant	Floorspace value
	Cent/sq. ft./day	*Sq. ft.*	*Number*	*Dol./yr.*	*Dol./sq. ft./yr.*
1	0.087	186,750	312	51,000	0.80
2	.182	143,000	260	68,000	1.50
3	.117	630,000	260	192,000	2.45
4	.154	307,200	260	123,000	2.22
5	.118	104,500	312	38,500	0.87
6	.102	510,750	312	163,000	0.77

that food residues often were lodged in corners of the container. This material became odorous and a source for fly breeding.

The project team particularly noted the lack of clear-cut lines of responsibility for solid waste management at the centers. Although management was often held accountable by local health authorities for center sanitation, managers often lacked authority to enforce regulations or to provide for required services. This confusion of authority was evident at several centers where tenants contracted individually with waste haulers for service. The manager had little or no control over the rates charged for service, or for the frequency or adequacy of the service. At centers where the management had cooperation from tenants and complete authority to provide for center security, the same relation did not apply to sanitation.

Future Plans for Waste Handling and Disposal

Management expressed no future plans to significantly modify their existing waste management methods. Most indicated that wastes were a continuing problem, however, and expressed interest in the study's purpose and findings. One manager recently evaluated the purchase of a collection truck and several metal bin containers, but after considering labor requirements and equipment costs, decided to continue using a private collection contractor. The installation of an industrial incinerator also was considered, but costs were believed excessive.

All managers were concerned with reducing operating costs to a minimum. Some overlooked the value of improvements that could be obtained for additional expenditures. At one center, management had been contacted on several occasions by a private refuse hauler who proposed an improved waste management system for the center. Because cost increases were required, management rejected the proposals even though service to the tenants and center sanitation would have been significantly improved.

Impact of Center Wastes on Community Waste Management

The impact of center wastes on existing community waste management systems was minor. The centers surveyed were located in urban areas where adequate facilities were available to dispose of large volumes of residential, commercial, and industrial solid wastes. Center wastes can be readily and satisfactorily disposed of in sanitary landfills and large municipal incinerators. For small municipalities employing incineration for disposal, the high moisture content of center food wastes could pose problems. However, as long as food and nonfood wastes from the centers are collected together, this problem is minimal.

The use of garbage grinders to dispose of food wastes to the sewer system could also be a problem. Sewage treatment and sewer system capacity in many urban areas are inadequate. Grinding center wastes for disposal to sewer systems could aggravate existing problems in such areas.

Regulatory Agency Requirements

Restrictions imposed on centers by local regulatory agencies often influenced methods of solid waste management. At two locations, garbage grinders were prohibited because the community sewerage systems were inadequate. As a result, increased amounts of food wastes were found in the wastes of these centers. At other centers, garbage grinders were permitted and tenants were satisfied with their use. Many cities will permit garbage grinders to be used by tenants or by a center if the installation meets specified requirements. Payment of sewer service charges may be required when garbage grinders are used.

Regulatory agencies forced closure of existing waste incinerators at some centers because they could not economically meet the more stringent requirements for smoke discharge. New incinerators can be constructed, provided they meet the requirements, but such installations are expensive and require trained operators to prevent problems.

Feeding garbage to hogs is permitted in all States provided the garbage is cooked before feeding. Food wastes from centers could be considered as garbage in most States, and local enforcement agencies could require that it be cooked by farmers before it is fed to hogs. Cooking is costly and smaller hog farmers could not afford to cook center food wastes unless charges were made to tenants or the center to cover this added expense.

Local health regulations generally require that food wastes be stored in covered waterproof containers and removed daily from all commercial establishments, including centers at many locations. This requirement was seldom enforced by local health authorities, however. In some locations, local health and safety codes prohibit the storing of combustible wastes in the same room with gas or electric meters.

Before considering any waste management system, center managers should familiarize themselves with local and State regulations affecting waste handling and disposal. Representatives of local regulatory agencies can advise the individual manager of special requirements for his center.

WASTE MANAGEMENT SYSTEM COMPONENTS

This section describes the basic components of a solid waste management system for food distribution centers and discusses size selection and cost considerations for each component.

System components are illustrated schematically in figure 13. These components include the waste storage container, waste collection, waste transport to the disposal site location, and final disposal. Not shown on the figure, but an important part of the system, is the street and paved area cleaning method. Final disposal may be a municipal incinerator, landfill, or other method. A center operated incinerator may be used in place of the waste collection component, and only the ash residue will then require transport to the final disposal site.

Garbage grinders can be used for disposal of the food portion of center wastes directly into the sewer system. Nonfood wastes must be disposed by other methods than the grinder.

Alternative combinations and types of components must be analyzed to determine the best system for a particular center.

Waste Storage Containers

Containers are used to store waste material for subsequent collection and should be located near the point of waste generation—that is, the individual tenant's unit, the center restaurant, or the center administrative office. Container needs are based on the volume of waste generated, the collection frequency, and the type of collection method used. Containers for waste storage are a basic element of any solid waste management system proposed for center use. Each tenant should have adequate, convenient storage capacity for wastes generated.

Volumes and types of waste materials generated by tenants will vary. According to measurements made during field surveys, the volume of waste ranged from ½ cubic yard to

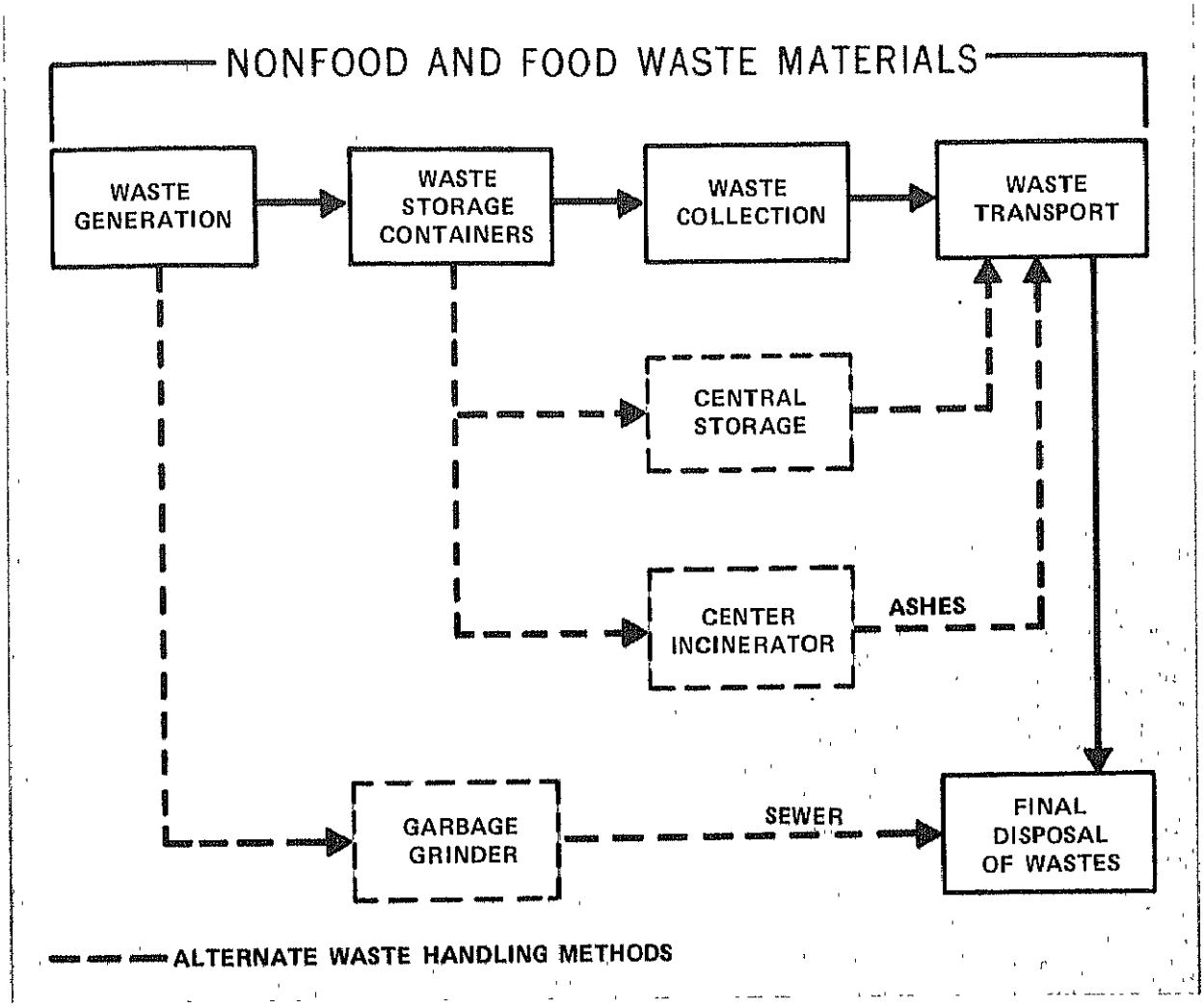


FIGURE 13.—Alternate methods of handling solid waste at food distribution centers.

4 cubic yards per unit each week. Tenants using more than one unit will have correspondingly higher amounts of waste. Thus, the total volume of waste per tenant will vary among tenants of a particular center.

To properly provide for container needs, conduct an onsite survey of quantities generated by each tenant. Alternatively, use results of the survey findings for first approximations and adjust as required after a short period of operating experience.

Use uniform container types and sizes within the center. Provide tenants generating larger volumes of waste with additional containers or empty their containers more frequently. For example, one tenant may find a single 1-cubic-yard container adequate for waste storage during the week, whereas another tenant may generate 3 to 4 cubic-yards of waste each week. The second tenant could use two 1-cubic yard containers, with collection service provided twice each week. Standardize containers within the center to facilitate efficient collection and to obtain the benefits of volume purchasing.

Because of the relatively high degree of putrescibility of food wastes, waste collection should be provided a minimum of twice each week for tenants. Restaurant wastes should be collected daily. Office wastes can be collected less frequently; once each week is adequate.

More frequent collections will reduce container requirements and will insure maintenance of sanitary conditions at the center.

The waste collection method must also be considered when containers are being selected. If containers are to be manually dumped directly into the collection vehicle, size them so that when they are full, a man can maneuver and tip them without difficulty. Fit containers to be dumped mechanically with appropriate lifting handles.

The least expensive containers are salvaged 55-gallon oil drums. These durable containers are appropriate for use when several waste generation points are located in the unit, as may be the case for a food-processing or culling operation, or when waste quantities generated are small. However, the 55-gallon drum is difficult to move and dump when it is filled with food wastes.

An improvement over the 55-gallon drum is the self-dumping container illustrated in figure 14. These containers are available in ½ to 3-cubic-yard sizes and are equipped with casters to facilitate movement from the tenant's stall to the collection vehicle.

Smaller (less than 2-cubic-yard) sizes of this container are readily tipped by one man, even when the containers are loaded with heavy food wastes. The 3-cubic-yard-size requires two men for safe dumping, particularly when this container is loaded with food waste.

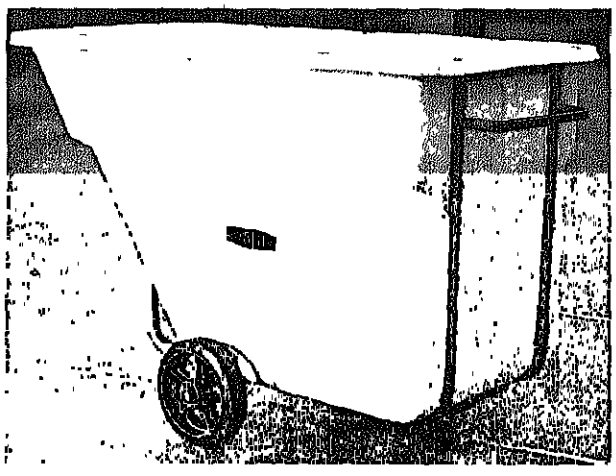


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FIGURE 14.—Self-dumping container.

Metal bins are available in sizes ranging from 1 to 10 cubic yards or more. Only smaller sizes of 3-cubic-yard capacity or less would normally be considered for use by individual tenants. Several tenants could use the larger size bin containers. The smaller metal bins can be equipped with casters to facilitate movement into tenant stalls for loading or can be transported with the forklift trucks, commonly used by tenants. Because of their size, the larger metal bins (more than 3 cubic yards) cannot be readily brought into the unit for convenient waste loading. They are best left on the rear dock or other storage location, with wastes taken to them. The weight of these bins, particularly when they are loaded with heavy food wastes, necessitates mechanical loading into collection vehicles. For this reason, metal bins are equipped with lifting handles.

Larger containers are available for central storage of the wastes from several tenants. These containers are located at a central location at ground level. Individual tenants must use smaller portable containers, such as those described above, to transport wastes to the larger container. The open-top, rolloff container is available in sizes ranging from 15 to 45 cubic yards or more. The container and contents are normally transported to the final disposal site by a tilt trailer and the emptied container is returned for refilling. Figure 15 illustrates an open-top, rolloff container and transport truck.

Figure 16 illustrates a compaction container used in conjunction with a stationary compactor: (Stationary compactors are described later in this report.) Compaction containers are used by several tenants for central storage and are available in sizes up to 45 cubic yards or more. The compaction container is completely enclosed and reinforced on all sides to withstand high compaction pressures. It would normally be located at a central location, such as the center or end of a loading dock convenient for use by several tenants. Again, smaller containers for transporting tenant wastes to the compactor would be required. A truck with a special hoist attachment similar to that shown in figure 15 is used to transport the filled container to the disposal site.

Space requirements for containers are de-

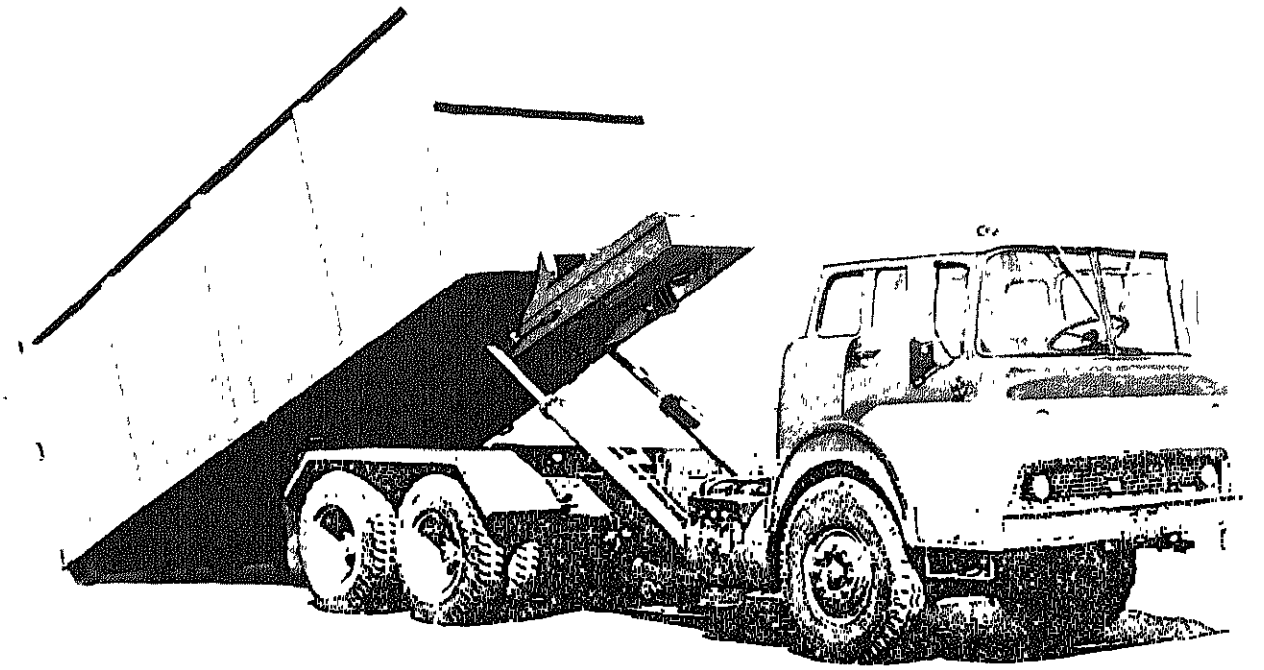

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FIGURE 15.—Open-top, rolloff container and transport equipment.

pendent on container capacity and frequency of collection service. For example, if a given volume of solid waste is generated weekly, dock space requirements for storage containers can be reduced 50 percent if the containers are emptied twice weekly rather than once weekly.

Self-dumping containers require 15 and 30 square feet of floorspace for a 1-cubic-yard- and a 3-cubic-yard container, respectively. Metal bins require from 15 square feet for a 1-cubic-yard size to 50 square feet for an 8-cubic-yard size. Area requirements for the open-top; rolloff containers range from 150 square feet for the 15-cubic-yard size to 185 square feet for the 45-cubic-yard size. Compaction containers require approximately the same area as that required for equivalent size rolloff containers.

Maintenance required for containers will vary, depending on the use received. With reasonable use, containers normally last 8 to 10 years. Routine maintenance should include painting, periodic cleaning, and spot welding. Self-dumping containers and smaller bins equipped with casters may require caster replacement if subjected to rough usage or heavy loads.

Container costs vary with quality, size, and type. Table 15 summarizes purchase costs for various container types and sizes. Costs will also vary in different geographic locations.

Many container manufacturers and private refuse haulers have container-lease plans available. Private haulers generally provide containers for customer use and include their cost in periodic service billings.

TABLE 15.—*Container costs*

Container type	Capacity	Purchase cost
	Cubic yard	*Dollars*
Barrel	Up to 55 gal.	Less than 15
Self-dumping hopper	½ to 3	165 to 400
Metal bin	1 to 8	90 to 700
Open-top rolloff	15 to 45	1,400 to 2,200
Compaction container	30 to 40	2,200 to 4,200

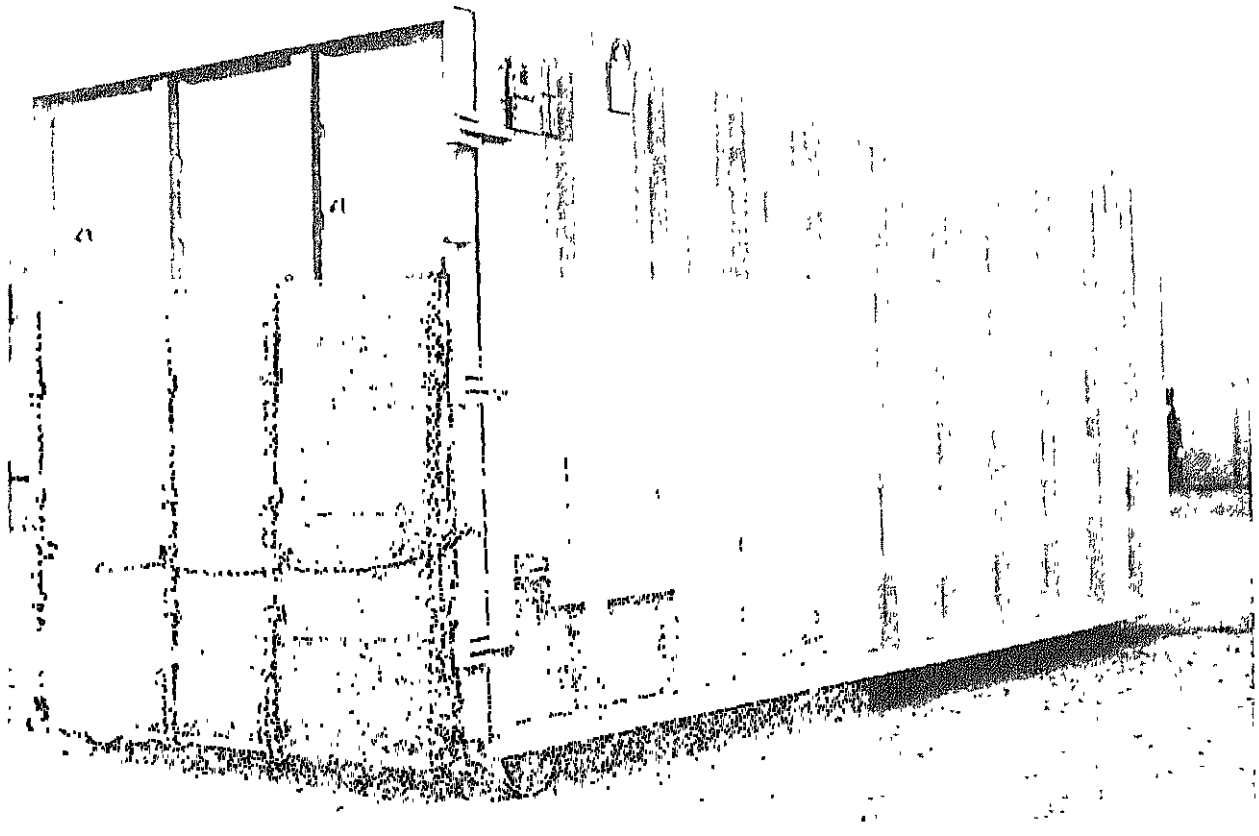

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FIGURE 16.—Compaction container.

Collection Equipment

Waste collection forms the next major component in the solid waste management system. Two categories of collection are discussed below.

1. The collection vehicle may be used to transport waste from the tenant units to a central storage container or incinerator located on the center premises.

2. The collection vehicle may transport waste materials from the center to a municipal or private disposal site located some distance from the center. Different types of equipment are required for each major category.

The volume of waste produced by the tenants, the number of containers to be serviced daily, and the transport distance largely determine the requirements for collection vehicles. In general, as haul distances increase, the capacity of the collection vehicle should also increase.

From the previously described surveys, the total volume of waste produced at each center was determined. Figure 3 illustrates the relationship between annual quantity of produce distributed and daily quantity of solid waste generated. The graph line on the figure was derived mathematically and indicates that for every 1,000 tons of produce distributed annually, approximately 70 pounds of solid waste are generated daily. Conversion of values taken from the figure to cubic yards can be made with the average density values given in table 5, page 10. Figure 3 can also be used to approximate waste volumes generated at other centers. As previously indicated, verification of values derived from figure 3 for a particular center is recommended.

A number of small three-wheeled collection vehicles are available, some of which provide for compaction of refuse. These vehicles are

highly maneuverable, can be operated by one man, and can be used to transport wastes from tenants' containers to a stationary compactor or rolloff bin at the center. The vehicles' small size would be advantageous for collections made during operating hours at the center. Use of the vehicles off the center premises, however, is not recommended. Figure 17 shows one such vehicle. Capacities range up to 3 cubic-yards. This type of vehicle also can be used for general cleanup work in team and house track areas and for litter cleanup along center perimeter fencing. Somewhat less efficient but also possible would be the use of a conventional pickup truck for this purpose. Tenant containers can also be transported with forklift trucks, commonly used for pallet handling at centers. Use of forklift trucks, however, would be limited to dock areas.

Several types of collection vehicles are available for use in transporting wastes longer distances. The rear-loading truck is equipped with a packing mechanism and, as the name implies, is loaded from the rear.

The rear-loading truck can be readily used in conjunction with barrels or self-dumping containers. Waste is deposited directly into a hopper at the rear of the truck from the loading dock at the center. When the hopper is filled, the packing cycle is actuated. During this cycle, a blade moves the waste material into the body of the truck and compacts the waste. The hopper is then ready for reloading.

The compaction achieved depends on the type of waste but generally varies between 2 and 2½ to 1. For example, if 3 cubic-yards of waste were placed into the hopper, and subjected to the packing cycle, the resulting compacted waste would occupy 1 or 1½ cubic yards of volume in the truck. A 20-cubic-yard-capacity rear loading truck thus has capacity for 40 to 50 cubic yards of loose waste. Rear-loading trucks can also be equipped with a cable device to facilitate dumping of larger bins of 4-, 5-, and 6-cubic yard capacities. Bin size and efficiency of this procedure are limited by the truck hopper capacity.

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FIGURE 17.—Three-wheeled collection vehicle dumping into rear-loading truck.

Rear loaders are primarily used for residential-type waste collection service. Because each container must be manually dumped into the hopper (except as noted above), collections at centers using this vehicle would be time consuming and somewhat inefficient.

The front-end-loading truck is equipped with a device to mechanically dump metal bins. It was specifically developed for commercial and industrial waste collection work. Bins of 1- to 8-cubic yard capacity can be dumped mechanically. Normally the entire dumping operation can be completed in less than 3 minutes. One of the main advantages of the vehicle is that it can be operated by one man, thus labor costs are reduced to a minimum. However, for feasible use, the truck must have ready access to the waste storage container location. During the loading cycle, a forklift apparatus raises the bin above the truck and dumps the contents of the bin into the top of the truck. Bins can be stored and loaded from the rear dock location with this vehicle. A front-end-loading collection truck is illustrated in figure 18.

Front-end-loading trucks are available with and without compaction capability. When equipped for compaction, volume reductions are similar to the rear-loading trucks described above.

A tilt-type collection truck is used for transporting large-capacity compaction and rolloff containers. It is equipped with a cable hoist for this purpose. Figure 19 illustrates the tilt-type truck and container in the loaded position.

The tilt-type truck has little value other than for transporting containers. On the other hand, both the rear loader and the front-end-loading trucks can be used for center cleanup activities in house and team track areas and for perimeter fence cleaning.

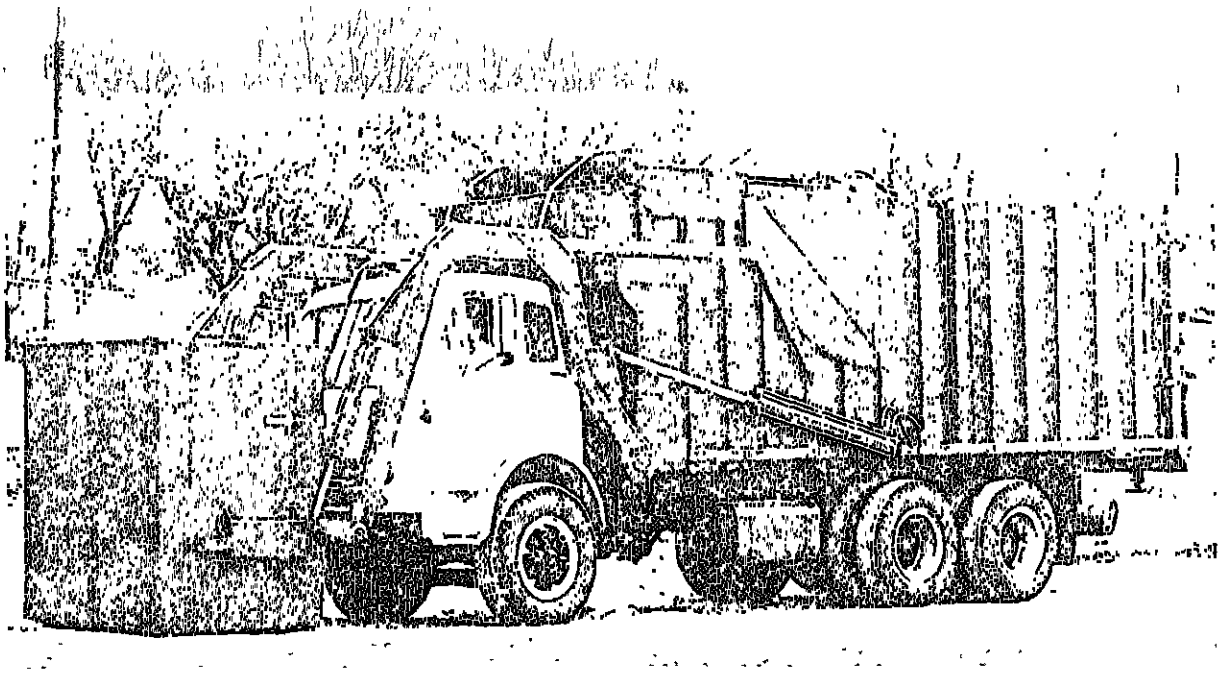

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FIGURE 18.—Front-end-loading collection truck.

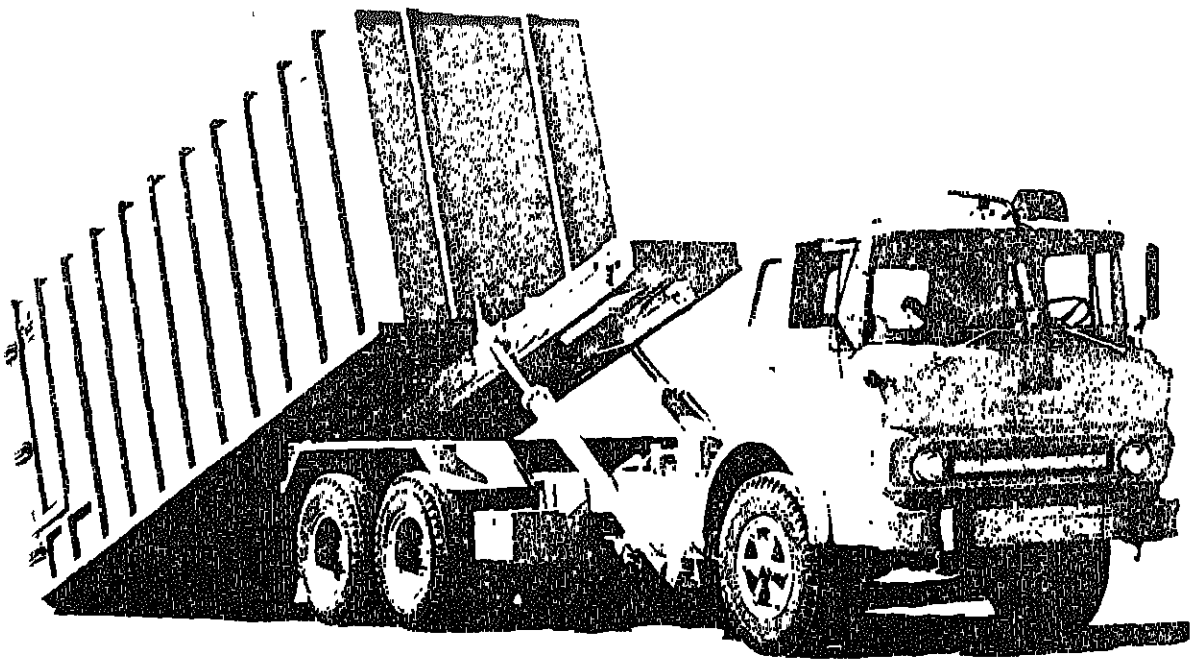

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FIGURE 19.—Tilt-type collection truck and reinforced enclosed compaction container.

Rear-loading compactor trucks can be purchased with capacities ranging from 6 to 40 cubic yards. Front loaders vary in capacity from 20 to 50 cubic yards. These values must be multiplied by 2 or 2.5 to determine their capacity in terms of loose refuse volume. Tilt-type trucks for hauling open-top, rolloff containers are available in sizes suitable for handling 15- to 50-cubic-yard containers.

Purchase costs for collection vehicles vary with size, chassis, and optional equipment. Table 16 presents representative purchase costs for collection vehicles.

The annual operating, maintenance, and depreciation costs—excluding labor for operation of larger collection vehicles—can be estimated at 40 to 50 percent of the purchase cost. For the smaller collection trucks, including the three-wheeled vehicle, these costs can be estimated at between 50 and 70 percent of the first cost.

Stationary Compactors

One of the newer developments in solid waste equipment has been the stationary compactor. It is designed for use when large volumes of solid waste are generated.

The stationary compactor permits the central storage of a large volume of center waste in a small area. When centrally located at the center (preferably immediately adjacent to a dock), the stationary compactor is available for use by tenants whenever needed. Storage container requirements of tenants can be reduced to a minimum by its use.

Figure 20 shows a stationary compactor installation and compaction container.

The compactor consists of a charge box and hopper opening into which waste is deposited. A hydraulically operated ram pushes the trash through an opening into an attached compaction container. Waste is compressed and completely enclosed in the compaction container, thereby reducing waste volume and minimizing fly and odor problems. The enclosed container also prevents scavenging of discarded produce by unauthorized persons.

Waste can be placed into the compactor hopper either mechanically or manually. When the attached container is full, it is detached from the compactor and hauled to the disposal site.

The operations of a stationary compactor are illustrated in figure 21. The stationary compactor can accept all types of refuse materials generated at centers, including food waste, wood pallets, paper, cardboard, other packaging materials, and sweepings from the streets and tenant areas.

Stationary compactors are classified in four categories—light duty, commercial/light industrial, heavy-duty industrial, and extra heavy duty. A commercial/light industrial type is normally adequate for use at centers. The size of this compactor is usually designated by its capacity in cubic yards of waste per hour. Available capacities range from 15 to over 800 cubic yards per hour. Space requirements vary with the capacity. Compactors with capacities of 15 to 160 cubic yards per hour require 30 to 40 square feet of area. Larger units require up

TABLE 16.—*Collection vehicle costs*

Vehicle	Capacity	Purchase cost
	Cubic yard	*Dollars*
Three-wheeled vehicle (onsite use only)	1 to 8	2,500 to 7,000
Rear-loading truck	6 to 40	8,500 to 35,000
Front-end loading truck	20 to 40	18,000 to 40,000
Tilt-type truck (excluding container)	15 to 50	21,000 to 25,000
Dump truck	5 to 12	7,500 to 17,000

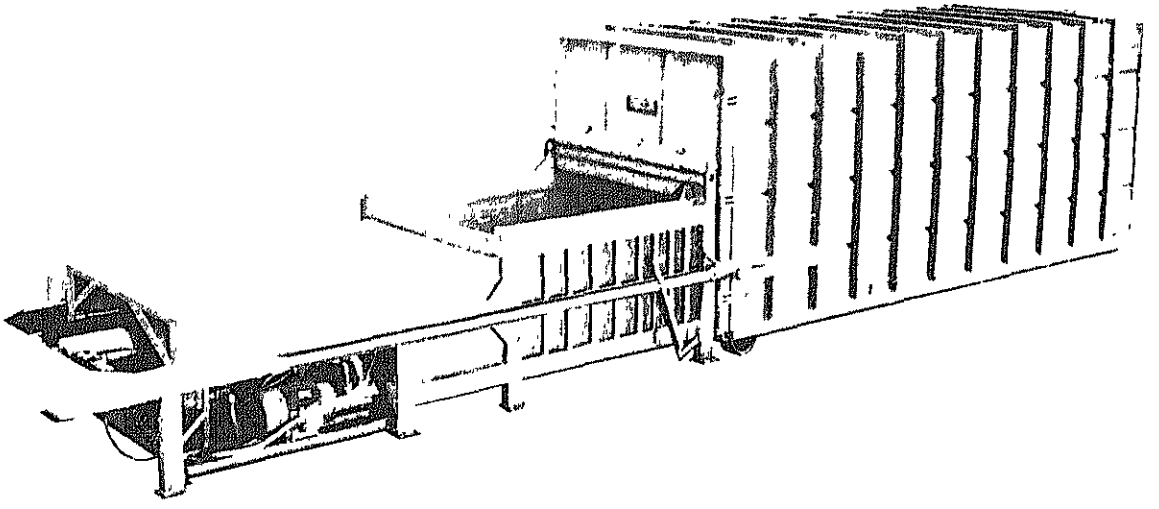

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FIGURE 20.—Stationary compactor and compaction container.

to 60 square feet of area. Additional area is required for the compaction container. A clear area must be maintained to allow access to the compactor by users and by the tilt-type truck that removes full container.

When a stationary compactor is selected, the hopper dimensions must be adequate to receive the largest items of waste. At the centers surveyed, wood pallets were the largest item, with approximate dimensions of 3½ feet by 4 feet. The sizes of the containers used by the tenants for waste storage must also be know because the hopper capacity should be at least as great as the container capacities to prevent spillage during dumping. Bin or barrel waste containers can be used for interim storage and transport of wastes to the stationary compactor. Mechanical loading devices are available as optional equipment on most compactors and must be used with heavier containers.

The reduction in volume of waste that takes place in the stationary compactor is called the compaction ratio. Compaction ratios will vary with the waste type but should average between 2 and 3 to 1. A single compaction unit can serve the entire center; however, the distance from tenant stalls to a single location may require the use of a collection system to transport wastes to the compactor. A second compactor unit may be considered in this case.

Maintenance of compaction units is normally limited to that required to keep electrical, hydraulic, and mechanical equipment in good repair. The area around the compactor and the compacting unit should be cleaned daily. A water hose is convenient for this purpose. An

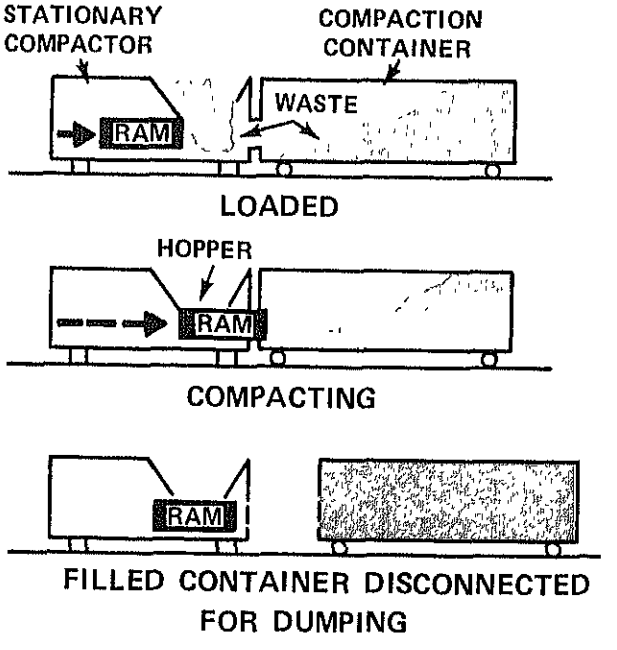

FIGURE 21.—Operations of the stationary compactor.

automatic deodorizer is available as an option that can aid in the control of odors in the hopper. A prepared solution is automatically sprayed into the hopper after the ram completes each cycle.

Table 17 shows the wide range of compactors available, and associated costs. In most localities, stationary compactors can be leased from distributors or from waste collection contractors. When a contractor provides the equipment, he also services the container. Stationary compactors are usually leased on a 3- to 5-year basis. Lease-purchase plans are generally available. Annual lease costs under a 5-year plan are also tabulated. The annual cost for a 3-year lease plan would be somewhat greater. Tabulated costs are for the compactor itself and do not include compactor installation, the compaction container, and optional equipment.

Installation costs range between $2,000 to $4,000, depending upon local conditions. A concrete slab, water, electrical, and sewer connections are required. A 4-foot-high wall or fence around the compactor is often installed to protect it from damage.

Incinerators

An incinerator operated by the center can be considered when large amounts of wood pallets, cardboard cartons, waste paper, and other combustible wastes are generated and when alternative means of waste disposal are located at long-haul distances from the center. Food wastes found at the centers are difficult to burn in incinerators due to their high mositure content. If the food wastes are combined with the combustible wastes mentioned above, they can be incinerated. However, in many instances, food wastes are generated without compensating quantities of combustible material.

An advantage of the incinerator is that wastes are disposed of near the source of generation. It is not necessary to provide for costly transport of waste to distant disposal locations. However, an incinerator must be operated by properly trained personnel to prevent air pollution problems.

A further disadvantage of the incinerator is its high purchase and installation cost. Many industrial incinerators have been closed as a result of stricter State and local air pollution control standards. Incinerators capable of meeting stringent standards are very expensive to construct and operate.

The multiple-chamber, batch-fed incinerator is most applicable for center use. It may be water cooled or refractory lined and can be equipped with moving grates. In the primary combustion chamber the material is dried, ignited, and burned, usually with the help of a gas burner. A secondary chamber, also gas fired, provides for further combustion, and removal of fly ash, and helps eliminate odors from stack gases.

Incinerator ratings are based on the types of waste and the burning capacity in pounds per hour. It is therefore necessary to determine the amount and type of waste to be burned for incinerator selection. Estimates can be made based on results of this study. Daily and seasonal variations in waste volumes must also be considered. Often the hours of incinerator operation can be adjusted to compensate for daily and seasonal variations in waste generation.

Factory-assembled incinerators have capacities ranging from 50 pounds up to 1,000 pounds per hour. Field-erected units can be obtained

TABLE 17.—*Stationary compactor costs*

Rated capacity of compactor	Range of compactor cost	Annual lease (5-year plan)
(Cu. yd./hr.)	*Dollars*	*Dollars*
35 to 90	1,500 to 4,000	400 to 1,000
90 to 125	4,000 to 6,000	1,000 to 1,500
125 to 250	6,000 to 9,500	1,500 to 2,500
250 to 500	9,500 to 14,000	2,500 to 3,500
500 to 720	14,000 to 16,000	2,800 to 4,000

with capacities of 500 pounds per hour and more. Each unit, whether package-type or field erected, must be designed for a particular center.

Space requirements for incinerators vary from 175 square feet for a 500-pound-per-hour unit to 375 square feet for a 2,000-pound-per-hour incinerator. Representatives of incinerator manufacturers can be helpful in making specific recommendations for a particular situation.

Many air pollution control agencies require that incinerators be approved prior to construction. Engineering designs and plans for the incinerator are inspected by the agency to insure compliance with code requirements. A permit for construction is granted if all requirements are met. Some agency restrictions on smoke emissions are so stringent that the use of expensive gas scrubbers are required. These add significantly to incinerator costs. Table 18 summarizes purchase and average installation costs for various-size incinerators. Labor and operating costs are additional.

Factory-assembled package incinerators require a concrete slab and a connection for natural gas. For larger incinerators, the installation includes field fabrication of the incinerator.

An incinerator requires routine maintenance for continuous, trouble-free operation. Weekly inspections, cleaning, lubrication of mechanical parts, and removal of clinkers and slag are required.

Operating costs for incinerators vary with labor costs, the type and quantity of waste burned, thoroughness of burning, and amount and type of auxiliary air pollution control equipment. Average costs per ton for incinerator operation and maintenance, and amortization of capital have been calculated for burning various quantities of typical center wastes and are presented in figure 22. The effect of air

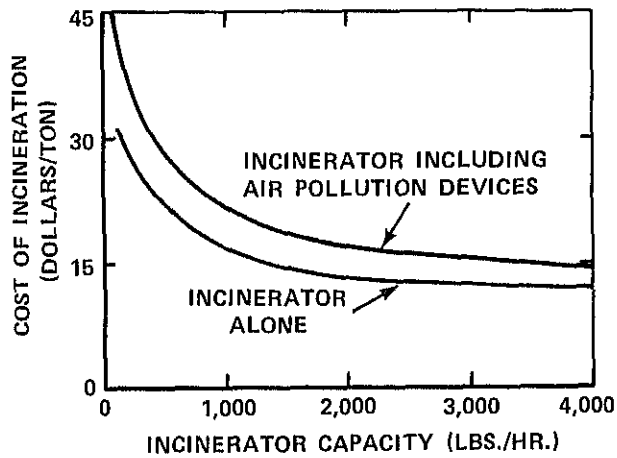

FIGURE 22.—Estimated incineration costs for center wastes.

TABLE 18.—*Estimated costs of installing a waste-disposal incinerator*

Capacity (lb./hr.)[1]	Range of purchase cost	Range of other costs	
		Air pollution control devices	Installation[2]
	Dollars	*Dollars*	*Dollars*
100	3,000 to 3,600	2,500 to 2,700	1,600 to 2,800
200	4,400 to 4,600	3,000 to 3,500	1,675 to 3,100
500	8,400 to 11,000	6,000 to 7,000	1,850 to 3,400
1,000	11,000 to 18,000	7,000 to 10,000	2,000 to 3,600
Total cost (purchase cost, air pollution control devices, and installation):			
1,500		25,000 to 50,000	
2,000		35,000 to 75,000	
2,500		50,000 to 100,000	

[1] Center waste composed of 50-percent food waste and 50-percent nonfood waste.
[2] Includes concrete slab and utilities.

pollution control devices on costs are shown also. Not included in the figure are the costs associated with waste storage, collection, and transport to the incinerator, and ash disposal.

Approximately 10 to 15 percent by weight of slag or ash material will remain following waste combustion. Disposal of this material will be required.

Figure 23 lists the considerations that should be evaluated in regard to installing an incinerator at a particular center. The relationship between the cost of disposing of waste by incineration and by transport for landfill disposal at distant locations is illustrated. To complete the analysis, the user of the chart must determine certain cost data for wastes, in dollars per ton or per cubic yard. First, obtain the cost for alternative disposal and plot this data on the graph (line A). The alternate disposal cost can be the charge made by the city or a private operator for waste disposal at a landfill or municipal incinerator. It does not include collection and transport to the disposal site.

The amortization, operating, and maintenance costs for an incinerator with the capacity required by the center can be obtained from figure 24 and plotted on the graph (line B) shown in figure 25. Next, estimate the cost for transporting waste from the center to the landfill or municipal incinerator. (The owning and operating costs of transport equipment are discussed earlier in this report.) Labor costs must be added to determine the total hourly cost of a waste transport truck. Since waste storage and collection costs would be similar, regardless of the alternative disposal method, these costs can be disregarded for purposes of the analysis.

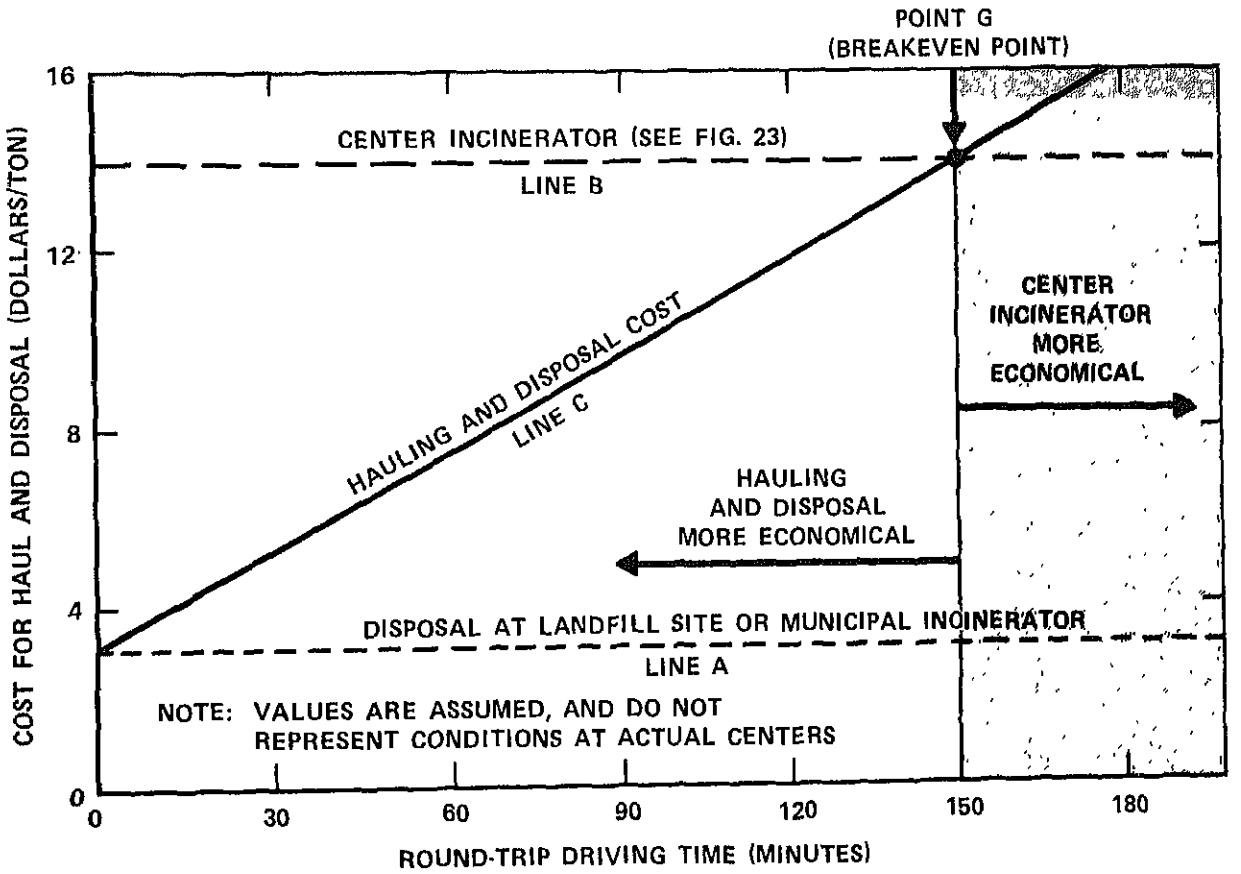

FIGURE 23.—Solid waste disposal. Relationship between cost of center incinerator and cost of hauling and disposal to distant landfill.

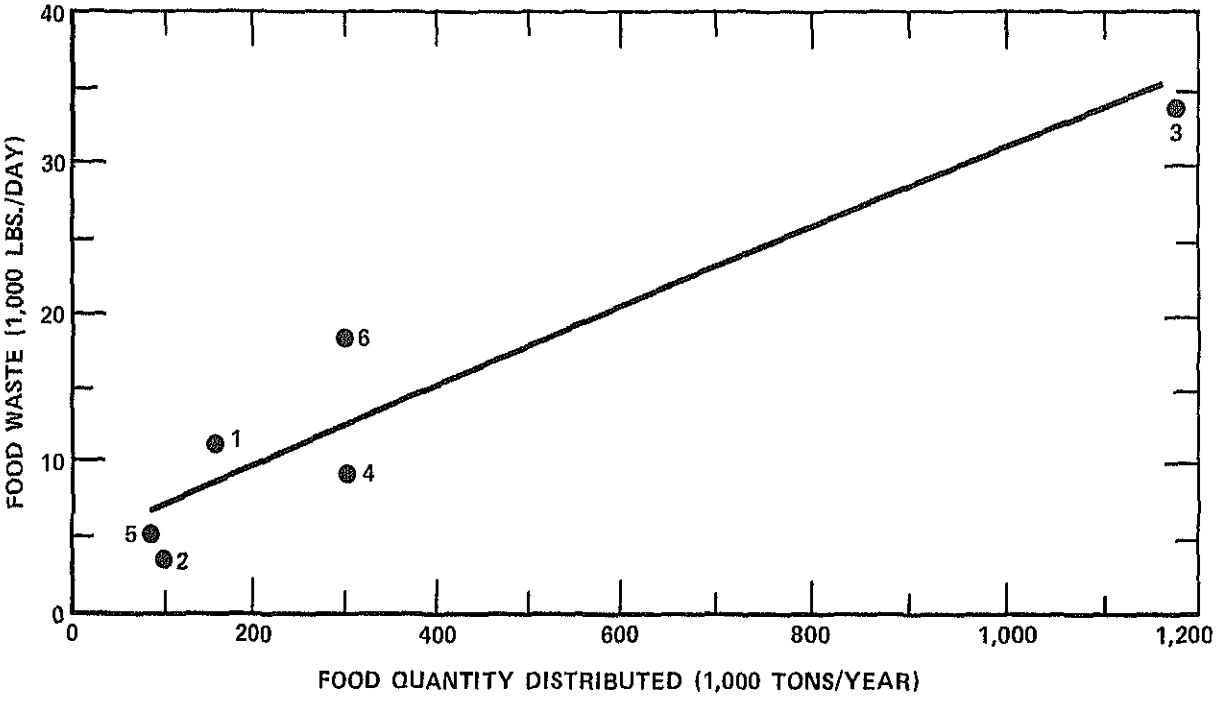

FIGURE 24.—Relationship between volume of food distributed and volume of food wastes generated.

Calculate cost per hour for transporting to the disposal site and add to the disposal cost (line A in the graph shown in figure 25) : Plot the combined cost for hauling and disposal for various round-trip travel times, such as 30 minutes, 90 minutes, and 150 minutes. (For purposes of estimating round-trip travel times, trucks can be assumed to operate at 30 m.p.h.) Draw a line through the plotting points (line C). Note that line C intersects line A at the vertical axis. Line C represents the haul plus disposal cost for waste transported to a distant disposal site. The point where incineration would become economically feasible is noted on the graph at point G, the "breakeven point." If the disposal site round-trip driving time is greater than that point G, the construction and operation of an incinerator would be more economical for center waste disposal than transporting the waste to a distant location.

Garbage Grinders

Garbage grinders can be used to dispose of both food trimmings and spoiled fruits and vegetables to the sanitary sewer system. Disposal of highly putrescible food wastes by this method can prevent many problems associated with waste storage, collection, and disposal.

Grinders can be installed and used by individual tenants or located at a central location to dispose of food wastes generated by many tenants. The logistics required to bring food waste to a central grinder location may make this method unfeasible for disposing of all food wastes from the center. However, a central grinder could be used for disposal of the large quantities of unsalable produce that occur at infrequent times. A disadvantage of using a central garbage grinder for disposal of all food wastes is the requirement for separate storage and collection of food wastes and of nonfood wastes.

Figure 24 illustrates the relationship between annual food quantities distributed and the volume of food wastes generated, as determined by the surveys. Food-processing operations at the center are the most significant sources of food wastes.

Garbage grinders can be installed either in

existing or in new sinks and sorting tables. Space for garbage grinders varies, depending on particular requirements. A new sink or sorting table with a garbage grinder would require approximately 40 square feet of floor area. This area would provide space for the grinder, a sink approximately 7 feet by 2½ feet and a 3-foot working area on one side of the table. Sorting tables and sinks can either be purchased as a package with the grinder or fabricated by the tenant.

Grinders intended for use at a central location in the center should be placed in groups of two or more in combination with a suitable trough. The minimum area required for this type of installation would be 225 to 250 square feet. This area would provide space for a 15- by 5-foot trough with two garbage grinders and access to all sides of the trough for waste deliveries.

A garbage grinder requires the proper combination of rotor size and horsepower to give the desired results. Garbage grinders suitable for tenant or center use would be in the 3- to 7½-hp. range. Consultation with a disposer sales representative can help in determining the proper unit to be purchased.

The rated capacities of garbage grinders are

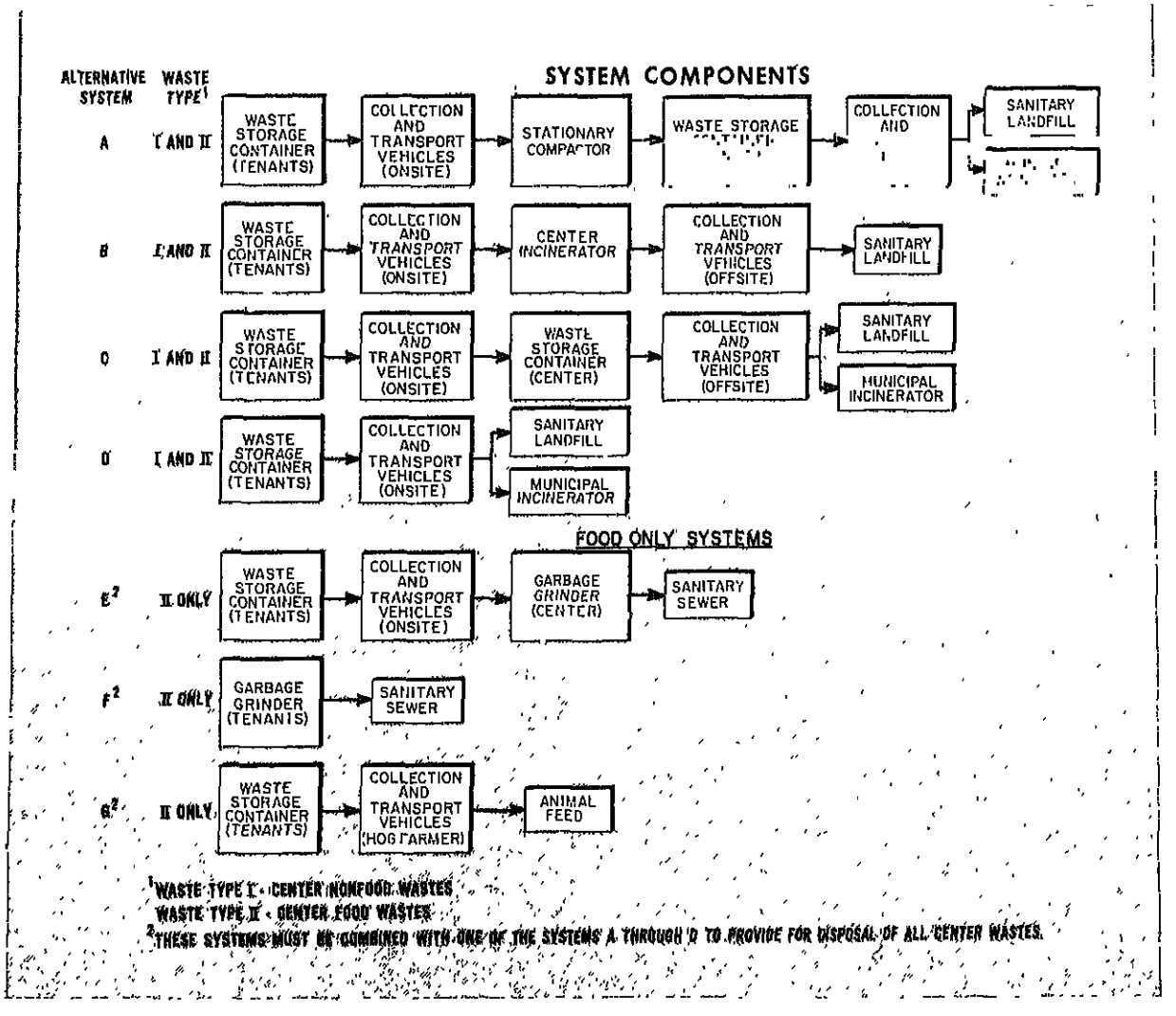

FIGURE 25.—Schematic diagrams of alternative solid waste management systems for wholesale food distribution centers.

based on manufacturers' tests with restaurant wastes. Rated capacities should be reduced about 25 percent for grinding fresh produce such as fruits and leafy vegetables. For fibrous vegetables such as celery stalks and artichoke leaves, the usable capacity should be reduced 80 percent from the rated capacity. Table 19 presents capacities for grinders and appropriate reductions for grinding vegetables and fruits and for grinding fiberous vegetable wastes.

Tenants considering the installation of a garbage grinder should make a survey of their operations to determine the volume of food waste generated daily and the hours during which the waste can be ground. If food preparation or processing is part of the operation, the grinder should be incorporated into the processing line. The hours of disposer operation would then be determined by the hours of line operation. The required pounds per hour of disposer capacity can be determined by making several measurements of waste quantities generated during certain time periods.

If installation of a grinder at a central location in a center is found desirable, another survey must be made to determine the total volume of food waste generated daily by the tenants. Figure 24 can be used to approximate the quantity. The composition of food waste should also be analyzed—that is, the portion made up of leafy vegetables and the portion made up of fibrous material.

Automatic water controls are recommended for use with a garbage grinder. The controls turn the flushing water on when the garbage grinder is operated and maintain water flow for 2 minutes or longer after the grinder has been inactivated. This insures proper flushing of the drain line.

When installation of garbage grinders is anticipated, contacts should be made with the regulatory agency having jurisdiction over the discharge of ground garbage to sanitary sewers. At some locations, laws prohibit the discharge of ground garbage into the sanitary sewer because of inadequate sewer lines or sewage treatment plant capacity. Grinders should be equipped with a 4-inch diameter drain line having a minimum number of elbows, tees, and other impediments to flow. Manufacturers normally recommend water flow rates of 6 to 10 gallons per minute (g.p.m.); however, with produce, 15 to 20 g.p.m. should be used. This additional water helps to flush the drain line.

Estimated purchase costs for various size grinders are presented in table 20. These prices are for the grinder only and do not include costs for installation or for work tables and sinks. Average installation costs range from $500 to $1,200, depending on the availability of sewer, electrical, and water connections.

Maintenance costs for properly operated garbage grinders are minimal. Cutting bars and cutters must be periodically replaced. If adequate water is used for flushing, costs for sewer cleaning will be negligible.

Hog Feeding

Food wastes from wholesale centers may be disposed of by hog feeding. Some municipalities have disposed of restaurant and household

TABLE 19.—*Capacities for garbage grinders*

Size (rated hp.) and rated capacity (lb./hr.)[1] of grinder	Capacity reduction for—	
	Fruits and leafy vegetables	Fibrous vegetables
	Lb./hr.	*Lb./hr.*
3 hp.—1,000 to 2,500	750 to 1,875	200 to 500
5 hp.—2,500 to 3,500	1,875 to 2,625	500 to 700
7½ hp.—4,000	3,000	800

[1] Based on restaurant waste.

TABLE 20.—*Estimated purchase costs of garbage grinders*

Size of grinder (rated hp.)	Range of estimated purchased costs [1]
	Dollars
3	800 to 1,100
5	1,150 to 1,400
7½	1,400 to 1,700
10	1,500 to 1,900

[1] Does not include worktables or sinks.

garbage by hog feeding for many years. This practice is losing popularity, however, particularly since the advent of the garbage grinder.

Nearly all States require that restaurant and household garbage be cooked before being fed to hogs. Hogs fed uncooked garbage containing meat scraps can become infected with the trichinosis worm. Humans can become infected with the worm when they eat pork from garbage-fed hogs. Although produce food wastes from centers do not contain meat scraps and, therefore, are not subject to trichinosis—worm infestation—many regulatory agencies do not distinguish this difference and require that all food wastes fed to hogs be cooked. Cooking of the waste is expensive, and because this cost is normally borne by the hog farmer, it reduces the potential value of the waste.

The feeding of center food wastes to hogs has certain advantages. Disposal of culled fruits and vegetables by this method can be very inexpensive if cooking is not required. Because of its food value, the farmer often will remove the waste at no charge. If several hog farmers are near the center, food wastes of each tenant can be removed daily, thus contributing to a more sanitary center at minimum cost.

There are, however, several disadvantages with this method of waste disposal. One disadvantage is that the hog farmer is interested in obtaining food wastes only. Quantities of paper, wood, and cardboard mixed with the food waste reduces food value, and the farmer may reject mixed wastes. Thus separate storage of food wastes by center tenants is desirable. However, separation of wastes requires the tenant to provide additional storage area and labor. Another disadvantage is that separate (and possibly more frequent) collection of food wastes may increase the number of vehicles entering the center during the hours of operation. In older centers where congestion is a problem, this added traffic could be detrimental to operations.

Unless organized and under contract to the center, hog farmers cannot be relied upon to provide uninterrupted collection service—a factor necessary to insure the maintenance of sanitary conditions on the center. The seasonal variations in food waste types and quantities may not correspond to the requirements for food by the hog farmer. Therefore, at times of high seasonal waste generation at the center, other disposal methods may have to be used.

In most urbanized areas of the country, few hog farmers operate within reasonable hauling distance of food distribution centers. The days of the entrepreneur farmer with 25 to 50 hogs on a small ranch are nearly gone. Today's successful hog farmer employs scientific methods and carefully regulated feeding programs for maximum returns. Variations in quantity and quality of food waste and more stringent health regulations have all but eliminated hog feeding as a viable alternative for waste disposal. Cooking requirements can economically be met only by larger operations handling many tons of food waste daily.

If hog feeding is considered as a disposal method, local regulatory agencies having jurisdiction over feeding of garbage to animals should be contacted to determine if these wastes can be fed directly to hogs without prior cooking. In addition, center management should establish carefully prepared rules under which the hog farmer would be required to operate. These rules are necessary to insure uninterrupted food waste removal and maintenance of sanitary center conditions.

Street Cleaning

Cleaning of streets and other paved areas is necessary to keep the center sanitary and neat in appearance. Common paved areas include streets, parking lots, and team and house

tracks. All of these areas should be regularly cleaned of waste materials.

The volume of waste that accumulates on streets or in other paved areas can be substantial. In the centers surveyed for this report, it was found that as much as 6 tons of waste was collected from streets and other paved areas each day. Ten to 20 percent was food waste. Proper containerization of tenant wastes can be expected to substantially reduce this volume.

The principal factors governing the operation and the administration of street-cleaning service are the character and quantity of street refuse, climate, traffic, parking, and the kind and condition of the street paving.

Two methods are commonly used for cleaning the streets and paved areas—manually and with powered equipment. Under existing conditions, some center areas can only be cleaned manually. An example of such a condition is unpaved rail track areas. Broomsweeping in inaccessible areas and handpicking of refuse from unpaved areas can be used.

The most efficient method of cleaning paved areas is with powered street sweepers and skip loaders. A smaller mechanical sweeper could be used on the dock areas as well as in hard-to-work areas, such as parking lots and along track areas. Many sizes are available to fit conditions at any center. For the more extensive paved areas, the larger mechanical sweeper should be used. Sweepers are available that collect the materials they sweep in a hopper. The contents of the hopper can then be dumped into an open truck for hauling to the disposal site, or into a central center container.

Street-cleaning operations are materially influenced by the character and condition of paving. Pavements in good repair enable more efficient and effective street-cleaning operations. Cracks in the pavement trap and retain dirt and debris. Wind can scatter this litter. Climatic and weather conditions also have an influence on selection of methods and the cost for cleaning operations. For example, rainfall will normally have a beneficial effect on the cleanliness of a street.

Traffic congestion may require that street sweeping be scheduled only at night. Some daytime street-sweeping operations can be completed in the areas where traffic is light and the parking is at a minimum.

Mechanical street sweepers usually operate most efficiently at speeds between 4 and 8 m.p.h. The area cleaned will vary with the amount of traffic congestion and the volume of waste on the paved areas. A sweeper can clean up to 20 acres of paved area daily. This figure is based on 6 hours of actual cleaning time and an average travel speed of 5 m.p.h. Sweepers have an effective sweeping width of approximately 6 feet.

A dump truck and skip loader or a dump truck equipped with a mechanical loader can be used in paved areas to remove wastes that cannot be picked up by sweepers. (The skip loader and dump truck can be used for other maintenance work at the center as well). The skip loader can be used to push wastes into a pile for loading into the dump truck. Two men are usually assigned to each dump truck used. The skip loader requires one man for operation.

Mechanical street sweepers require normal preventative maintenance. Brooms must be replaced regularly to keep the sweeping operations effective. Replacement is normally needed after 400 to 500 miles of sweeping.

A small sweeper for use on dock areas costs approximately $4,000. Larger mechanical street sweepers cost between $12,000 and $15,000, depending on the type and make. The owning and operating cost of large street sweepers, excluding operator, can be estimated at $10 per hour. This cost estimate includes maintenance, fuel, and depreciation.

The costs of dump trucks vary, depending on the size of bed, number of axles, and whether the engine is gasoline or diesel. Dump truck prices start at about $7,500 for a two-axle truck with a 5-cubic-yard dump bed. A larger three-axle truck may cost as much as $17,000 and can haul 10 to 12 cubic yards. The mechanical loading buckets for dump trucks have capacities of ¾ to 1½ cubic yards and lifting capacities of 3,000 to 5,000 pounds. (Their cost, including installation and hydraulic controls, ranges from $4,000 to $7,500.)

Skip loaders with a 1- or 2-cubic-yard bucket range in price from $15,000 to $24,000. Skip loaders can be purchased for $8,000 and up,

depending on their horsepower and bucket capacity. For use at a center, a skip loader should have a bucket capacity of about 1 cubic yard. Owning and operating costs for a skip loader can be estimated at about $6 per hour, plus labor.

ALTERNATIVE WASTE MANAGEMENT SYSTEMS

The previous section describes the waste management system components applicable for use in wholesale food distribution centers, as well as general size selection and cost considerations. Figure 25 presents schematic diagrams of the major components of seven alternative solid waste management systems. Systems A through D can be applied to food and nonfood wastes combined, or to nonfood wastes separately. Each system includes waste storage containers for tenants. (Although figure 27 is concerned with food and nonfood wastes only, systems A through D can also be applied to disposing of street litter and railcar dunnage, discussed earlier under "Waste Management System Components.") Systems E through G are for management of food wastes only. The proper system, the combination of components, and the type and size of equipment will vary from center to center, depending on local conditions. These conditions include availability and cost of labor, expected cooperation of tenants, authority of center management, location of disposal site, availability of capital, local regulations, physical layout of the center, and other factors.

Table 21 presents a summary of purchase and annual costs for equipment associated with each system component. Labor, operating, and maintenance costs are excluded from the table because these costs will depend upon specific sizes of components selected and on local conditions. Guides for evaluating these costs were presented in the previous section of this report.

The responsibility for center waste management should rest with the manager. Administration of all center waste collection services by the manager is preferable to having each tenant contract for service from a private hauler, or having two or more firms or agencies provide waste disposal service at the center. Delegating responsibility for waste management to the center manager can enable him to properly coordinate waste collection and disposal service and thus obtain a cleaner center at less cost.

The center, through the manager, may either contract with a private firm or establish its own capability—in terms of labor and equipment—to provide for waste collection and disposal service. Advantages and disadvantages are associated with each alternative.

Private waste haulers depend on solid waste collection and disposal for their livelihood. Because of intense competition, they generally use efficient waste-handling systems. However, some haulers may avoid providing extra service, or otherwise slight needed service, to save costs. Avoid the detrimental effect that this practice would have on center sanitation by basing the contract on carefully worded service specifications.

Before a contract for service is negotiated, specifications describing the service to be rendered are needed. These specifications include details on the contract terms, bonding and insurance, basis for payment, and service to be provided. Appendix B provides a sample contract for engaging the services of a private hauler to provide solid waste collection and disposal for a center. The sample is nonencompassing and would require modification to suit the needs of any particular center. Competent legal advice to modify the agreement to suit local conditions should be sought.

Many haulers will complete a survey of center conditions and recommend alternative waste management systems complete with cost data. This service should be used prior to the formulation of the contract specifications. At least two haulers should be requested to make these recommendations. The recommendations of these haulers should be carefully reviewed in light of the findings of this report to avoid excessive charges or the need for costly contract modification after the contract has been

TABLE 21.—*Summary of purchase and annual costs*[1] *for waste management system components*

1. WASTE STORAGE CONTAINERS

Index	Type	Capacity (cu. yd.)	Purchase cost ($)	Annual[2] cost ($)
a	Barrel	Up to 55 gal.	Less than 15	Less than 2.75
b	Self-dumping hopper	½ to 3	165 to 400	30 to 74
c	Metal bin	1 to 8	90 to 700	16 to 130
d	Open top rolloff	15 to 45	1,400 to 2,200	260 to 410
e	Compaction container	30 to 40	2,200 to 4,200	410 to 780

2. COLLECTION AND TRANSPORT VEHICLES

Index	Type	Capacity (cu. yd.)	Purchase cost ($)	Annual[3] cost ($)
a	Three-wheeled vehicle	1¼ to 3	2,500 to 7,000	460 to 1,300
b	Rear-loading truck	6 to 40	8,500 to 35,000	[3]1,570 to 5,950
c	Front-end loading truck	20 to 40	18,000 to 40,000	[3]2,780 to 6,850
d	Tilt-trailer truck	15 to 50	21,000 to 25,000	[3]3,340 to 4,100
e	Dump truck	5 to 12	7,500 to 17,000	1,400 to 3,150

3. STATIONARY COMPACTORS

Rated capacity of compactor (cu. yd./hr.)	Purchase cost ($)	Annual cost[2] ($)
35 to 90	1,500 to 4,000	280 to 740
90 to 125	4,000 to 6,000	740 to 1,110
125 to 250	6,000 to 9,500	1,110 to 1,760
250 to 500	9,500 to 14,000	1,760 to 2,600
500 to 720	14,000 to 16,000	2,600 to 2,970

4. INCINERATORS

Capacity (lb./hr.)	Purchase cost[4] of incinerator ($)	Annual cost[5] ($)
100	7,100 to 9,100	670 to 860
200	9,075 to 11,200	860 to 1,060
500	16,250 to 21,400	1,530 to 2,020
1,000	20,000 to 31,600	1,900 to 3,000
1,500	25,000 to 50,000	2,350 to 4,700
2,000	35,000 to 75,000	3,300 to 7,100
2,500	50,000 to 100,000	4,700 to 9,400

5. GARBAGE GRINDERS

Rated hp.	Purchase cost of grinder only ($)	Annual cost ($)[6]
3	800 to 1,100	150 to 200
5	1,150 to 1,400	210 to 260
7½	1,400 to 1,700	260 to 315
10	1,500 to 1,900	280 to 350

[1] Excludes labor, operating, and maintenance costs.
[2] Based on 7-year life and 7-percent interest.
[3] Based on 7-year life and 7-percent interest with $3,000 salvage value.
[4] Includes air pollution control devices and average installation costs.
[5] Based on 20-year life and 7-percent interest.
[6] Based on 10-year life and 7-percent interest.

engineer retained for this purpose.

As part of the contract, the private hauler should be required to supply each tenant with an adequate container or adequate containers for waste storage, and to provide a minimum of twice a week service to each tenant. Container ownership would remain with the hauler, who should also be required to maintain the containers in good repair and in a sanitary condition.

The contract should be written between the center manager and the hauler. All service payments should originate from and be authorized by the manager. These payments should be contingent upon the hauler's providing the required level of service to each tenant.

This arrangement places the manager in a favorable negotiating position with private haulers, which is desirable if the sanitation needs of all tenants are to be provided on a routine and economical basis. Because the hauler's costs of billing and risks of nonpayment are reduced, he can provide needed service at less cost. Many haulers can also provide service for cleaning streets and other paved areas on a routine basis, if desired.

In general, only large centers should consider the use of center labor and equipment for solid waste collection and disposal work. Small centers should contract with a competent, established private hauler for required services. For purposes of this report, centers are classed as "large" or "small" on the basis of:

- Number of waste storage containers to be collected and the required frequency of collection.
- Distance to the waste disposal site.
- Area of the center (acres).

To be efficient, equipment and collection crews should be used as near to 8 hours each day as possible. If there are fewer containers to be serviced than is justified by the size of the crew, costs will rise rapidly. The private hauler can compensate for this problem by using his equipment on other collection work after the center service has been provided.

A single front-end-loading truck can service bin containers at the rate of one container each 6 minutes if the containers are located on the

could provide space for 50 cubic yards of waste material. If metal bins have a 2-cubic-yard capacity, 25 bins would be required to fill the truck. At the rate of 6 minutes for each container, the truck would require 2½ hours to complete the load.

Next, the collection vehicle must travel to the disposal site. The time required to travel to the site and back depends on total distance and traffic conditions. Assuming a 20-mile round trip haul at an average speed of 30 m.p.h., and 15 minutes for dumping, the truck would return to the center in 55 minutes.

At this point, nearly 3½ hours of the desired 8-hour day for truck and crew would have elapsed and 25 bins would have been serviced. If the process were repeated, the truck would complete emptying a total of fifty 2-cubic-yard bins in about 7 hours of the working day. Thus, efficient use of this equipment and crew requires that fifty 2-cubic-yard containers be serviced daily, 5 days each week.

Assuming container contents to average 500 pounds each, the total weight for the contents of 50 containers would be 25,000 pounds or 12½ tons of waste to be collected per day. A center generating 12½ tons of waste per day would be expected to receive approximately 1,250 tons of produce daily (see appendix C). Of the centers surveyed, center 3 only exceeded this size. (See appendix C for recommended system for center 3.)

A similar calculation can be made for street and paved area cleaning capability of one sweeper and driver. As previously mentioned, a mechanical street sweeper can sweep up to 20 acres daily. A center with less than this area cannot properly use the equipment and would be better served by a private hauler.

of waste management operations and routine center maintenance work, as well. Initial planning of the system is most important and assistance should be sought from a competent consulting engineering firm knowledgeable in the solid waste field. The firm should complete a waste survey of the center to determine the quantities and types of solid waste generated by each tenant and to establish individual waste storage requirements. In addition, the effect of certain constraints on the system must be determined. Some of these are listed below:

- Center building configurations and locations of existing and future waste storage containers.
- Center operating hours and period when waste collections can be made without disrupting tenant operations.
- Location and availability of local disposal sites.
- Tenant building design (dock heights, access for collection vehicles, availability of power and water and sewer connections).
- Center area used for parking, team tracks, and streets.
- Local regulations that affect waste storage, handling, and disposal.

The engineer can formulate and recommend a cost-effective solid waste management system comprising applicable components discussed previously, including labor, equipment, and capital requirements. He should assist in implementing the system until it is operating smoothly. Appendix C contains a sample equipment and cost analysis for solid waste management at center 3.

The above examples indicate the considerations necessary when the use of center equipment and crews for waste collection and disposal is evaluated. Other factors noted previously will also affect the decision.

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APPENDIX A: FOOD DISTRIBUTION CENTER SOLID WASTE DATA FORM

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
Research Contract No. 12-14-100-10322(52)

SCS ENGINEERS
4014 Long Beach Blvd.
Long Beach, California
Form 0970-1

I. GENERAL

Center Name: _____ Date of Survey: _____

Address: _____
Street City Zip

II. PERSONS INTERVIEWED

Name: _____ Title: _____

_____ _____

_____ _____

III. FOOD TYPES DISTRIBUTED

Food Type	Area of Center (sq.ft)[1]	Food Volume[2] Annual	Survey Month/%[3]	Day[3] (%) Mon	Tue	Wed	Thur	Fri	Sat
Fresh Fruits & Vegetables			/						
Meats			/						
Poultry			/						
Dairy Products			/						
Fish			/						
Grocery Products			/						
Other Foods (describe)			/						
			/						
			/						
Total for All Foods			/						

Notes: 1 - That portion of the center normally allocated for receiving, display, storage and transfer of the particular food type.
2 - Indicate units of measure and correlate weight and volume, tons & cu. yds.
3 - Expressed as percent of maximum month and daily average.

Comment: _____

_____

_____

IV. DESCRIPTION OF WASTE MATERIALS

A. Food Wastes[1]

Food Type	Waste Type[2]	Waste Description[2] Moisture	Putrescibility	Combustibility	Compressibility
Fresh Fruits & Vegetables					
Meats					
Poultry					
Dairy Products					
Fish					
Grocery Products					
Other Foods (describe)					

Notes: 1 - Waste originating from the food only (see below for packaging wastes)
2 - See code below (moisture content is percent of wet weight)

Code	Waste Type[1]	Moisture	Putrescibility	Combustibility	Compressibility
A	Spoiled Food	under 45%	Inert	Inert	Low
B	Food Scraps	45 to 60%	Low	Low	Medium
C	Other (Specify)	61 to 80%	Medium	Medium	High
D	-	over 80%	High	High	-

B. Packaging & Other Wastes [3]

	Waste Type[4]	Waste Description[4] Moisture	Putrescibility	Combustibility	Compressibility
Fresh Fruits & Vegetables					
Meats					
Poultry					
Dairy Products					
Fish					
Grocery Products					
Other Foods (describe)					
Non-Food Wastes (describe) Office					

Notes: 3 - Non-Food Wastes
4 - See code below

Code	Waste Type[3]	Code	Waste Type[3]
A	Corrugated Cartons	C	Paper
B	Wood Scraps	D	Other (describe)

V. QUANTITY OF WASTE MATERIAL[1]

Food Type	Daily Waste Quantity (lbs./cu. yds.) Food Wastes A	B	C	Non-Food Wastes A	B	C	D	Comments
Fresh Fruits & Vegetables	/	/	/	/	/	/	/	
Meats	/	/	/	/	/	/	/	
Poultry	/	/	/	/	/	/	/	
Dairy Products	/	/	/	/	/	/	/	
Fish	/	/	/	/	/	/	/	
Grocery Products	/	/	/	/	/	/	/	
Other Foods (describe)	/	/	/	/	/	/	/	
	/	/	/	/	/	/	/	
	/	/	/	/	/	/	/	
Non-Food Waste Sources Office	/	/	/	/	/	/	/	
	/	/	/	/	/	/	/	
	/	/	/	/	/	/	/	

Notes: 1-Based on Center records and measurements on site.

Code	Food Wastes	Non-Food Wastes
A	Spoiled Food	Corrugated Cartons
B	Food Scraps	Wood Scraps
C	Other (Specify)	Paper
D	-	Other (describe)

Additional Comments:

APPENDIX B: SAMPLE CONTRACT FOR PRIVATE HAULER SERVICE [1]

MEMORANDUM of Agreement between (center name) (address), (city) hereinafter referred to as "Center" and (contractor) (address) (city) hereinafter referred to as the "Contractor."

Whereas the Center desires to engage the services of the Contractor for the period (starting date) to (termination date) related to the collection and disposal of solid waste from (center location); and

Whereas the Contractor is prepared and able to render above mentioned services to the Center on the terms and conditions set out in this Agreement;

Now therefore, this Agreement witnesseth that, in consideration of the Convenants herein contained, the Center and the Contractor hereby agree as follows:

1. SCOPE:

A. The Contractor undertakes to provide the Center with solid waste collection and disposal services, and for this purpose to furnish the labor, storage containers, equipment, and facilities necessary to remove solid wastes from the premises of the Center and to dispose of same. For purposes of this Agreement, the term "solid waste" shall include, but shall not be limited to, spoiled and culled fruits and vegetables, produce trimmings, cartons, boxes, crates, debris, paper, wood, and restaurant wastes resulting from activities within (center location).

B. Solid wastes to be removed shall be placed on the loading platforms or in the loading areas, from which the Contractor will load its trucks. The Contractor shall be responsible for avoiding spillage or scattering of solid wastes over the loading platform or loading area floors, and shall remove and broom clean such spillage should it occur.

C. The Contractor will furnish each tenant of the Center as many metal containers as may be required by the volume of solid waste to be removed and in any event a minimum of 1. Such containers shall have hinged covers and casters, and shall be of 2-cubic-yard capacity each. These containers will remain the property of the Contractor, and any depreciation, maintenance, repair and replacement thereof shall be for his account.

2. FREQUENCY OF SERVICE

Pickups for the purpose of removing solid waste will be made by the Contractor every day of the week from Monday to Saturday inclusive. Each tenant shall be provided service a minimum of twice each week. The number of pickups will be as required, to the end that undue accumulation of solid waste will not occur on the loading platform or in the loading area. All collections shall be made daily between the hours of _____ (time) and _____ (time).

3. CONSIDERATION

A. In full and complete consideration of the performance by the Contractor of his obligations under this Agreement, the Center shall pay to the Contractor:

[1] Adapted from "a sample contract for commercial or industrial pickup," in Sanitation Industry Yearbook. Ed. 8, p. 6. Solid Waste Management Refuse Removal Journal. 1971.

(1) In 1971—a fixed sum of $_____.

(2) In 1972—a fixed sum of $_____.

(3) In 1973—a fixed sum of $_____.

B. The above payments shall cover all labor, equipment, and facilities, including containers and required insurance coverage under this Agreement, and shall not be subject to increase during the entire period of this Agreement on any grounds, whether for increases in the cost to the Contractor of labor, insurance, equipment, materials, licenses, taxes or the type or quantity of solid waste; or for any other reason whatsoever.

C. Sums payable to the Contractor under this Agreement will be paid to it in 12 equal monthly installments. Within one week after the end of each calendar month, the Contractor will submit to the Center an invoice certifying that it has performed the services herein for the previous month. Within one week after its receipt, the Center will pay the Contractor the installment corresponding to the month covered by such invoice.

D. The Contractor shall not be entitled to any payment which is not expressly provided for in this Agreement.

4. WARRANTIES BY CONTRACTOR

A. The Contractor warrants that it holds valid all required dumping permits and agrees to maintain the same and comply fully with all laws, regulations and ordinances applicable to the services to be provided by it hereunder.

B. The Contractor shall maintain for the duration of this Agreement such insurance as will adequately protect the Contractor, its employees and agents, and the Center, and tenants, their employees and agents, from claims under Workmen's Compensation Acts and other claims for damages for personal injury, including death, or for damage to property, both real and personal, which may arise from operations under this agreement, whether such operation be by the Contractor or by anyone directly or indirectly employed by it. The Contractor also shall indemnify and hold the Center, and tenants, their employees and agents harmless in respect of any and all such claims. Contractor shall deliver at the time of signing the form of Certificates of Insurance that he is complying with the provisions of the above paragraph.

C. The Contractor shall not employ any labor or use any material which may be the cause of a strike on the Center site.

5. STATUS OF CONTRACTOR

The Contractor shall be deemed to be an independent contractor for purposes of this Agreement. Accordingly, neither the Contractor nor any of his employees shall be considered an agent, employee or servant of the Center, and the Contractor agrees to indemnify and hold the Center harmless from any claims by its employees in connection with the performance by such employees of services under this Agreement.

6. APPLICABILITY TO NEW BUILDINGS CONSTRUCTION

As provided for in point 3 above, the price payable to the Contractor hereunder shall not be subject to increase for any reason. Nothwithstanding those provisions of point 3 and the preceding sentence, however, in the event of construction of new buildings within the present Center area, which directly results in an increase of 20 percent or more in the average volume of solid waste, the Contractor shall be entitled to an additional payment for the increase in volume of solid waste, the amount of which additional payment shall be mutually agreed upon by the Parties

ie event that the Parties are unable to agree on a satisfactory additional fee, and provided fur-
ier that the mere fact that new construction is commenced within the present Center area shall
ot constitute a basis for renegotiation or alteration of any other provision of this Agreement.

. DURATION

This Agreement shall be deemed as having entered into force as of _____(date)_____ and nless extended by mutual agreement in writing not later than thirty (30) days prior to its ermination date, this Agreement shall terminate on _____(date)_____.

. TERMINATION OF AGREEMENT

In the event of non-fulfillment or unsatisfactory execution by the Contractor of any of his obgations under this agreement, the Center shall give notice in writing to the Contractor and give he Contractor such time as may be reasonably required to set right the matters under complaint. f at the end of such reasonable period of time the Contractor has not rectified the complaint, the 'enter shall have the right to terminate this Agreement forthwith.

. MISCELLANEOUS PROVISIONS

The rights and obligations of the Contractor under this Agreement shall not be assignable.

0. AMENDMENTS

1. No amendment to this Agreement shall be binding unless made in writing and duly xecuted by the Parties hereto.

Accepted:	(Contractor)		(Center)
By:	_____	By:	_____
Title:	_____	Title:	_____
Date:	_____	Date:	_____

APPENDIX C: SAMPLE ANALYSIS OF CENTER SOLID WASTE MANAGEMENT EQUIPMENT AND EQUIPMENT COST

Alternative combinations and types of waste management components must be analyzed to determine the best system for a particular center. The following is a simplified example of the steps necessary for determining the best waste management system for center 3. The analysis is in three parts: (1) Equipment and manpower requirements, (2) annual operating costs, and (3) cost per ton of refuse collected. Tenant refuse and street cleaning are also considered. Assumptions required are stated in the example.

Data used in the example were derived during the field survey at Center No. 3. Where the data are significantly different from the usual case, a statement to this effect is made.

Refuse tonnage: Daily tonnage picked up from the tenants at the market was 26.1 tons. (See table 6, page 11.)

Center total
Refuse tonnage: 8,600 tons/yr. (table 6)
Operation: 5 days/week

I. Equipment and manpower requirements.

1. Containers and collection equipment.

a. Assumptions:

- Compaction ratio of 2:1—that is, 2 cu. yd. of refuse in the container will be compressed to 1 cu. yd. in the packer truck.
- Collection of tenant wastes should be completed at least twice weekly. To facilitate efficient equipment utilization, equipment should be used for collections each day. Therefore, schedules should require that approximately 40 percent of the tenants will have their containers emptied each day. This requirement will result in each tenant's receiving collection service twice each week (to facilitate three-times-per-week collection, approximately 60 percent of the tenants would have to be serviced each day during the 5-day work week).
- Container pickup rate averages 6 min./container.
- Containers—2 cu. yd. bins.
- Collection vehicle—30 cu. yd. front-end loader.
- Approximately 500 lbs. of refuse per container.

b. Number of containers:

$$\frac{26.1 \text{ tons}}{\text{day}} \times \frac{2{,}000 \text{ pounds}}{\text{ton}} \times \frac{1 \text{ container}}{500 \text{ pounds}} = 105 \text{,2-cu. yd. containers required for daily accumulation.}$$

Inasmuch as collections are made from 40 percent of the tenants each day and the average tenant must store his trash for 2½ days between collections, the total number of containers required for the center would be 2½ × 105 or 262 containers.

c. Containers per truck load:

30 cu. yd. (truck size × 2 cu. yd. (container size) × ½ (compaction ratio) = 30 containers per truck load

d. Collection time:

$$\frac{30 \text{ containers}}{\text{truck}} \times \frac{6 \text{ min.}}{\text{container}} \times \frac{1 \text{ hour}}{60 \text{ min.}} = \text{3-hour collection time per truck}$$

2. Haul and disposal time.
   a. Assumptions:
      - Disposal site is a 2-mile round trip from Center No. 3. (The typical center may be a 20-mile or more round trip from the disposal site).
      - Truck haul speed is 10 m.p.h. because of poor road conditions. (Usual speeds are 20 m.p.h. for surface streets and 45 m.p.h. for freeways).
      - Time at disposal site is 15 min.

   b. Round-trip travel time:

$$\frac{2 \text{ mile}}{\text{trip}} \times \frac{\text{hour}}{10 \text{ miles}} \times \frac{60 \text{ min.}}{\text{hour}} = 12 \text{ min. per trip}$$

   c. Total time per load:

Collection time + travel time + disposal time = 3 hr. + 12 min. + 15 min. = 3 hr. 27 min. per round trip

   d. Number of trucks. The truck can make two loads and trips in 6 hr. 54 min. (2 trips per 8 hr. day). Servicing an average of 105 containers on a daily schedule would require the following number of trucks:

$$\text{No of trucks} = \frac{105 \text{ (containers) (truck)}}{60 \text{ (containers) (day)}} = 1.75 \text{ (rounded to 2)} = 2 \text{ trucks per day}$$

Therefore, the following equipment and manpower will be sufficient for providing refuse pickup service twice each week to tenants at center 3:

262—2 cu. yd. metal bins.
2—30 cu. yd. front-end-loading collection vehicles
2—collection truck operators

3. Street sweeping equipment.
   a. Assumptions:
      - Streets and parking areas total 2,465,000 sq. ft. (table 3, page 8.)
      - One-fourth of the area is swept daily (heavy-use areas) and the rest twice each week.
      - The house track area (226,800 sq. ft.) and team track area (235,500 sq. ft.) is paved and swept twice each week.
      - A mechanical sweeper can sweep 20 acres per 8-hr. day (page 40).

   b. Number of mechanical sweepers required:

Areas swept daily—

$$\frac{(0.25 \times 2{,}465{,}000 \text{ sq. ft.}) \times 5 \text{ days}}{\text{(day)} \; \frac{100 \text{ acres}}{\text{sweeper}} \times \frac{43{,}560 \text{ sq. ft.}}{\text{acre}} \; \text{(week)}} = 0.71 \text{ sweeper}$$

Areas swept twice weekly—

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Sweepers required = 1.24 (rounded to 2)

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   b. Round-trip travel time:

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   c. Total time per load:

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   b. Number of mechanical sweepers required:

Areas swept daily—

$$\frac{(0.25 \times 2{,}465{,}000 \text{ sq. ft.}) \times 5 \text{ days}}{\text{(day)} \; \frac{100 \text{ acres}}{\text{sweeper}} \times \frac{43{,}560 \text{ sq. ft.}}{\text{acre}} \; \text{(week)}} = 0.71 \text{ sweeper}$$

Areas swept twice weekly—

$$\frac{(0.75 \times 2{,}465{,}000 \text{ sq. ft.}) \times 5 \text{ days}}{\text{(day)} \; \frac{100 \text{ acres}}{\text{sweeper}} \times \frac{43{,}560 \text{ sq. ft.}}{\text{acre}} \; \text{(week)}} = 0.53 \text{ sweeper}$$

Sweepers required = 1.24 (rounded to 2)

c. The following equipment and manpower will be sufficient to clean the areas specified above.
2 mechanical street sweepers.
2 street sweeper operators.
1 dump truck.
1 skip loader.
1 dump truck operator.
1 skip loader operator.

II. Equipment and Operating costs.

1. Annual labor cost.
Labor costs are based on estimated salaries paid in the city where Center No. 3 is located. Table 22 presents the required manpower and total annual labor cost for this sample.

2. Equipment cost and annual operating cost:
Initial cost for equipment and the annual cost of operating the equipment is shown in table 23.
Assumptions:
- All equipment is assumed to have a 7-year life.
- Interest rate is 7 percent.
- The rear-loading collection vehicle is assumed to have a salvage value of $3,000; remaining equipment has zero salvage.

III. Cost for collecting and disposing of waste.

1. Annual cost:

Cost for labor	$ 85,000
Cost for operating equipment	42,650
Disposal cost 8,600 tons/yr. at $4 ton	34,400
Total	162,050

Total annual cost for collection and disposal:

$$\text{Cost per ton} = \frac{\$162{,}050}{8{,}600 \text{ tons}} = \$18.84/\text{ton}$$

2. Proposed annual saving:
The cost for waste collection and disposal at center 3 is $41.31/ton (table 13, page 22). A saving of $22.47 per ton is indicated. The annual saving for 8,600 tons of waste would be over $193,000.

TABLE 22.—*Manpower requirements and annual labor costs for solid waste management*

Type of employee	Manpower requirement: Number	Manpower requirement: Annual[1] salary	Annual labor cost
		Dollars	*Dollars*
Assistant center manager[2]	⅓	13,500	4,500
Collection truck driver	2	10,250	20,500
Street sweeper operator	2	10,250	20,500
Dump truck operator[3]	1	10,250	10,250
Skip loader operator[3]	1	10,250	10,250
Maintenance man[4]	2	9,500	19,000
Total cost	--	--	$85,000

[1] Includes fringe benefits.

[2] Assumption: Assistant center manager spends one-third of his time involved with solid waste management operations.

[3] Assumption: Dump truck operator and skip loader operator are not employed a full 8 hours each day for street cleaning. The remaining time is available for routine center maintenance and for cleaning problems, such as occasional large dumps of railroad-car dunnage and broken pallets.

[4] For maintenance of equipment and containers only.

TABLE 23.—*Initial cost and annual operating cost of equipment*

Unit of equipment and operating cost factor	Units required	Purchase cost: Per unit	Purchase cost: All units	Annual depreciation, all units
	Number	*Dollar*	*Dollar*	*Dollar*
Equipment unit: Collection truck (front-end-loading, 30-cu. ft. capacity)	2	30,000	60,000	10,000
Refuse bins (2 cu. yd. capacity for use with above collection trucks).	262	150	40,300	7,450
Mechanical street sweeper	2	13,500	27,000	5,000
Dump truck	1	7,000	7,000	1,300
Skip loader	1	16,000	16,000	2,950

	Dollar
Cost factor:	
Total annual depreciation, all units	26,700
Repair parts (7% of initial cost)	8,400
Licenses and insurance	3,000
Fuel and oil	4,550
Total annual equipment operating cost	$42,650

GLOSSARY

ASHES

Residue from the burning of wood, paper, cardboard, and other combustible materials.

CENTER (FOOD DISTRIBUTION CENTER)

Location for the wholesale distribution of fresh fruits and vegetables and other food products.

COMPACTION CONTAINER

A heavy-duty waste container used in conjunction with a stationary compactor. When the container is full, it is detached from the compactor and transported to the disposal site and returned for refilling.

CONTAINER

Receptacle for the storage of solid wastes.

CONTRACTOR

Company or individual who contracts for the collection and disposal of solid wastes from the center.

DUNNAGE

The solid waste material remaining after a railcar has been unloaded, usually consisting of packing material (such as wood, paper, and cardboard) and small amounts of food waste.

EMISSION

The gases, vapor, and particles that reach the atmosphere from waste incineration.

FOOD WASTE

Organic waste from food-processing and handling-operations. Includes spoiled food, unsalable fruits and vegetables, food scraps, and food trimmings.

FRONT-END LOADER
Collection vehicle with arms to engage and lift the container (usually 1 to 8-cubic-yard capacity), and empty it into the vehicle body.

GARBAGE
(See Solid Waste)

GARBAGE GRINDING
A method of uniformly reducing food waste or putrescibles and placing the ground product into the sanitary sewer system. The ground garbage, which should pass through a sewage treatment plant, must still be disposed of as sewage sludge after treatment.

GRATE
Surface with suitable openings that supports refuse and permits passage of air through burning waste.

HAUL DISTANCE
Distance the collection truck must travel from the center to a sanitary landfill or other waste disposal facility.

HAUL TIME
Elapsed time spent hauling refuse from the center to the disposal facility.

HOG FEEDING
A process in which the food part of a center's solid waste is disposed of by being fed to hogs.

HOUSE TRACKS
The railroad tracks immediately adjacent to and accessible from the tenant buildings.

INCINERATION
The process of burning solid, semisolid or gaseous combustible wastes to an inoffensive gas and sterile residue containing little or no combustible material.

INCINERATOR
An arrangement of chambers and equipment designed for burning solid, semisolid, or gaseous combustible waste into an inoffensive gas and a sterile residue containing little or no combustible material.

INCINERATOR CAPACITY
The amount of solid and semisolid wastes, or both, that can be burned in a given period to an inoffensive gas and a sterile residue, containing little or no combustible material. Usually expressed in pounds per hour.

INCINERATOR, MUNICIPAL
A specifically designed, site-erected unit for disposal of refuse collected from residential, commercial, and industrial sources.

LANDFILL
(See Sanitary Landfill)

LITTER
Wastes scattered about in a careless manner.

NONFOOD WASTES
Includes corrugated cartons, paper, wood, office wastes, and street litter resulting from normal operations of the center.

ONSITE DISPOSAL
Includes all methods of disposal conducted on the center premises.

PACKER TRUCK
An enclosed vehicle for solid waste collection with a mechanism within the body capable of compressing and distributing solid waste.

PRIVATE HAULER
(See Contractor)

PUTRESCIBLE WASTE
Capable of being decomposed by microorganisms with sufficient rapidity to cause nuisances from odors and gases.

REFUSE
(See Solid Waste)

SANITARY LANDFILL
A method of disposing of solid wastes on land without creating nuisances or hazards to public health or safety.

SANITARY SEWER
A sewer that carries liquid and water-borne wastes from residences, commercial buildings, industrial plants, and institutions, together with minor quantities of ground, storm, and surface waters that are not admitted intentionally.

SANITATION
The control of all those factors in man's physical environment that exercise or may ex-

ercise a deleterious effect on his physical development, health, and survival.

SOLID WASTE

Center food and nonfood wastes resulting from normal center operations.

SOLID WASTE MANAGEMENT SYSTEM

A coordinated, interacting, and interdependent unit of facilities, equipment, and labor for collecting, removing, and disposing of solid wastes.

TEAM TRACKS

A group of railroad track sidings located some distance from the tenant buildings and used for storing full and empty railcars at the center.

WHOLESALE FOOD DISTRIBUTION CENTER

(see Center)

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